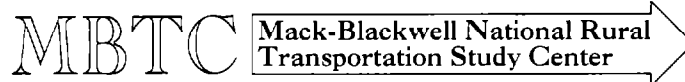
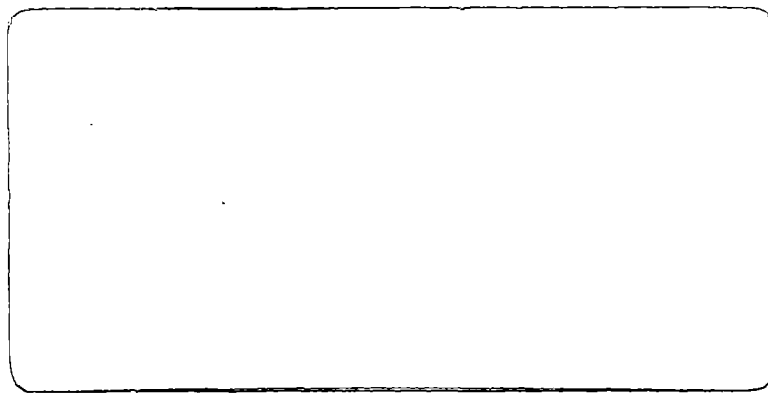




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**ONLINE BENCHMARKING SYSTEM FOR
TRANSPORTATION PROVIDERS
MBTC 2015**

Manuel Rossetti

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CHAPTER 1: INTRODUCTION

In order to remain competitive, transportation service providers, such as trucking firms, must constantly evaluate their operations, management structures, information systems, and customer relations with respect to their competitors. One of the standard approaches used by industry to evaluate performance is known as benchmarking. Benchmarking is a process by which companies determine the best practices that lead to exceptional performance; however, benchmarking is a complicated and time-consuming process. First, the data necessary to support a benchmarking analysis can be difficult and time-consuming to obtain. For example, companies may be reluctant to share the data necessary to determine best practices because of proprietary or competitive concerns. Second, performance metrics required to perform the benchmarking can be difficult to determine and difficult to interpret their relevance to best practices. Third, finding the best practice in a subject area can be a lengthy task that requires expertise and analysis techniques. Fourth, communication with benchmarking partners must be effective and require full cooperation from all parties. As a result, a system is needed that can aid in the process of benchmarking. The system or tool should partially or completely solve the problems mentioned above. In particular, the system should allow the users to track the performance metrics in specific subject areas, such as customer service or product service performance. Since users are interested in identifying best practices and performance metrics, the system should facilitate the data collection process within these subject areas. In addition, the system must be designed in a user friendly way so that users can quickly apply and learn the system. In turn, communication of all parties involved is improved because the system allows a systematic approach to benchmarking.

There are many systematic ways of conducting a benchmarking study; however, an “online benchmarking” system is one of the innovative ways that one can use to benchmark a transportation company. This research examines the development of an on-line benchmarking system to facilitate the benchmarking of transportation providers. We have implemented the system in prototype form as an “on-line benchmarking system (OBS)”. In particular, the system allows transportation providers to recommend performance metrics, rate their importance, classify the metrics into service categories, and develop other specifications for a performance measurement system. In addition, the system allows for the on-line collection of performance metric values through an on-line survey process. The data is collected and stored in a database for later benchmarking analysis against other participating benchmarking parties in an anonymous fashion. Finally, the system facilitates best practice analysis through a multi-criteria process based on a balanced score card approach. The metrics are categorized according to the four categories in the balance scorecard approach to performance measurement.

This project addresses the need for timely, accurate and comprehensive information concerning the performance and capabilities of transportation and local delivery providers in the form of an on-line benchmarking database. In addition to an on-line benchmarking database, this project examines the development of innovative technologies and methodologies to allow the interactive analysis of transportation providers compared to best practices.

Benchmarking surveys are one of the most popular techniques used to collect performance data. For instance, a transportation provider may perform a survey to

examine some specific operations, such as, customer relations, delivery operations, or e-commerce strategies of peer-group companies. In this project, we investigate the development of a benchmarking system with online capabilities to facilitate benchmarking survey and data collection. The system will not only contain information from the survey but will also contain information about the surveys, such as performance metrics, survey questions, subject areas, etc.

The primary goal of this project is to support innovation and dissemination of knowledge within the area of benchmarking analysis for transportation carriers. The following are contributions of the project.

- Standardized performance metrics for transportation carriers within all areas of operation.
- Innovative tools for the display and comparison of benchmark results to indicate the performance of Transportation Company.

In this report, we present the details of the collected performance metrics and the structure of the online benchmarking system in the context of trucking carriers. In addition, an online application based on Simple Multi-Attribute Rating Techniques (SMART) will be discussed in full. SMART is the method that we use to prioritize the performance of carriers. We begin with a review of literature relevant to the benchmarking of transportation service providers.

CHAPTER 2: LITERATURE REVIEW

According to Zivan (1992), then Xerox's vice president for logistics and distribution, a pioneer in developing benchmarking processes, defines benchmarking as the heart of the planning process for any company that holds customer satisfaction as its highest priority. Indeed, benchmarking is an integral part of any quality improvement process. Performance metrics are used to indicate the performance of an organization within a benchmarking analysis and within performance measurement systems.

According to Watson, et. al (1999), performance metrics can be defined as the analytical tools in the performance measurement process that take measurements, display results, and determine subsequent actions. A specific value of a metric indicates the performance of a specific area in an organization. There are many performance metrics that are important to a company's operation. In general, an enterprise will have hundreds of potential performance metrics to be incorporated into their performance measurement systems. Because of the large number of potential performance metrics, it is often very useful to classify the metrics into subject areas. For example, Watson et al. (1999) proposed a comprehensive logistics performance framework and a best practice template in their work. A total of one hundred and twelve metrics were identified and categorized into four groups, which were "cycle time", "quality", "financial", and "resource". In addition, a list of eighty-two best practices was compiled from two hundred and sixty six best practices that matched the appropriate metrics. In addition, their work "identifies benchmarking that links qualitative values (best practices) with quantitative measurement (performance metrics), across the value chain" (1999).

Bravo and Related Research

In this section, we discuss the research project known as BRAVO performed by Eindhoven University in the Netherlands and research related to the BRAVO study. The key findings related to this research are:

- 1) The importance of segmentation (or categorization) of trucking companies.
- 2) The identification of critical success factors or critical performance metrics (financial and operational metrics only) that directly affect the performance of companies.
- 3) The identification of a performance metrics list that are related to the financial and operational aspects of the company.
- 4) The identification of relationships between financial and operational performance metrics.

In the article “Performance measurement in the transportation and distribution sector” by Donselaar et. al. (1998), the authors address the importance of using performance indicators other than financial because of the growing trend of quality improvement in many industries. In addition, the authors are interested in identifying the relationship between financial and operational measures that had an obvious impact on the performance of a company. As a result, the authors conduct a research project known as BRAVO that concentrated on logistics performance from the transportation providers’ point of view. The BRAVO project studies marketing, information technology, inter-firm co-operation, strategy and operations of trucking companies.

In order to measure performance, three different scores are used to distinguish successful and less successful companies. The scores are named BRAVO-1, BRAVO-2, and BRAVO-3. "BRAVO-1 is a score in the long term and consists of ratios concerning the growth, productivity, solvency and profitability of the company. BRAVO-3 is a score to measure the operational performance at segment level. This score is defined as the turnover per segment (or category) in proportion to the relevant costs in the segment. BRAVO-2 score is derived from the BRAVO-3 scores. This is done by taking the weighted sum of the BRAVO-3 scores over the segments in which the company operates. Generally, the authors use a weighting method to calculate the BRAVO score. However, no detail on the weighting method is given.

The objective of the BRAVO project is to develop a list of performance metrics that was critical to the operations of transportation service providers. The project team conducted two separate surveys. One survey was conducted on shippers and another one was conducted on transportation providers. About 150 companies responded to the survey. The companies were categorized into successful and less successful group by looking at their strategy, marketing, information technology, cooperation, and operations aspects.

In the BRAVO project, the authors segmented or categorized all of the 150 companies into three different groups, which were "transportation", "distribution" and "warehousing". In addition, trucks were divided into general container trucks and specialized trucks. As a result, performance data (financial, operational) was collected according to the segmentation (categorization). Based on the segmentation of the trucking

companies, the authors constructed two models, which were the “Transportation” model and “Distribution Model”. Both models attempted explicitly to identify the relationship between financial performance metrics and operational performance metrics. The models were constructed with performance metrics arranged hierarchically. In addition, mathematical relationships were primarily used as the indicators of the relationship that existed among the various metrics.

After the models had been completed, the authors constructed a method that was used to identify the “Critical Success Factors (CSF)”, or critical performance metrics (which are the performance metrics that have a crucial impact on the operations of companies). The approach used by the authors to identify the CSF and the results of the project were reported by Wouters et. al. (1999) The method was made up of five steps:

- 1) Perform a one-factor correlation analysis on all the measures to find out which operational measures are strongly associated with financial measures.
- 2) Compare the average value of the operational performance measures for the companies that are performing well.
- 3) Find the operational measures that have the highest impact
- 4) Discuss with experts to decided if the data need further segmentation (segmentation is used by the authors to indicate the categorization of metrics)
- 5) Repeat step 2 to 4 if necessary with new segmentation.

In the following, we discuss the CSF as identified by the Bravo authors using the approach above. We begin by first looking into the Transportation model, and then the Distribution model.

Transportation model

The model consisted of many operational factors that related to one another. The purpose of the model was to determine the most influential factors that were associated with operational performance. In this model, companies were further segmented into Short Distance group and Long Distance group because the average distance per trip had a significant effect on the BRAVO-3 score. The results in the short distance sub-segment showed that both “average wages per driver” and “average load in a truck” were the most important metrics that were highly correlated to the performance of companies. Improvement made to these metrics could result in better operational performance; therefore, the metrics were classified as “Critical Success Factor (CSF)”. On the other hand, the results in the long distance sub-segment showed that “turnover per trip”, “turnover per km per 1000kg”, and “turnover per truck” were highly correlated with the BRAVO-3 score (Note that “turnover” was used by the authors to indicate “revenue”); however, the three metrics should be used to diagnose the situation of a company only, because they do not suggest a solution the operational performance of a company due to their relation to financial performance. Therefore, the metrics were not classified as CSF. On the other hand, the “percentage of km (kilometer) driven empty” and “distance traveled per trip” were considered as CSFs. Therefore, improvement made to these metrics can directly improve the operational performance.

The Distribution Model

In the distribution model, the focus of operation lies on stopping instead of driving. Therefore, operational performance of companies is determined mostly by stopping

operations. In this model, companies were further divided into small drop weight and large drop weight groups.

Results for the small drop weight companies showed that “variable cost per km” was directly proportional to the operational performance of the company. Even though turnover per km was highly correlated with operational performance, the metric was associated with financial performance as well. Therefore, this metric could not be considered as CSF. Other important operational metrics included “number of stops per trip” and “average distance between two stops”.

Results for the large drop weight companies suggested that “turnover per km” was highly correlated with BRAVO-3 score. Since “turnover per km” was associated with financial performance, it was not classified as CSF; however, “distance between two stops” was determined to be a CSF. In this case, the shorter the distance between two stops, the better the performance of the company. Finally, the size of a company (defined as number of trucks and annual revenue of the company) was determined to be a CSF.

All the CSF identified in the Bravo research enables individual companies to study the company’s current situation so that improvement plans could be carried out in the future. The limitation of the project was that it concentrated on operational performance and disregarded overhead costs, because overhead was not considered significant in this sector. In addition, company performance was compared with one CSF only. However,

there might be more than one CSF that could account for the success or failure of a company.

The research served as an important guideline for our project so that we have better understanding of certain performance metrics of a transportation company. On the other hand, CSF and some other metrics that were presented in this study were included in our performance metric list. For example, revenue/truck, average load, average speed, number of truck per company and load factor. The different models and their evaluations were also important because the authors studied the problem from different point of views. In addition, the segmentation of transportation companies in the BRAVO project highlighted the importance of categorization when comparing performance. In the article “An innovative survey in the transportation and distribution sector”, Donselaar stressed on the importance of proper categorization of trucking companies when conducting the BRAVO project. In the authors own words: “*Segmentation is crucial for benchmarking: comparing apples and pears makes little sense* (1997).” In fact, the author argued that segmentation of transportation and Distribution Companies were important in the selection of CSFs and it was an important condition for the measurement of success. In our project, we integrated Doonselar’s segmentation concept by including an important “carrier categorization” questionnaire in our benchmarking system.

The BRAVO research indicates that the selection of key performance metrics is extremely important so that the performance of a company can be accurately and precisely measured. Since the selection of key performance metrics is important, we

investigate more on this subject. Caplice et al (1994) have a structured approach to select crucial performance metrics. Caplice et. al.(1994) proposed eight criteria to consider when selecting performance metrics for logistics and business purposes, which were: 1) Validity, 2) Robustness, 3) Usefulness, 4) Integration, 5) Economy, 6) Compatibility, 7) Level of detail, and 8) Behavioral soundness. In addition, they suggested three forms of measurement that could be used to capture the performance of business activities, which were 1) Utilization, 2) Productivity, and 3) Effectiveness (1994).

Surveys can be an effective tool to identify areas that may contain key performance metrics. A study by Tang et al. (2001) applied the Analytical Hierarchy Process (AHP) to measure the performance of outbound logistic processes within Taiwan's notebook computer industry. By conducting a survey, they identified seven key performance metric areas that closely related to logistic activities: 1) information system, 2) customer service, 3) order process, 4) distribution process, 5) assembly process, 6) inventory control, and 7) warehouse management.

The identification of relationships in performance metrics can be useful in constructing a performance measurement system or conducting a benchmarking project. Boyd and Cox (1997) used a technique known as the "negative branch" to evaluate the cause and effect relationships of performance metrics within an organization. According to them, the construction of a "Negative branch" is a four step process: *"1) Write down the positive effects that are expected to result from the action, 2) Write down the negative effects that might result from the action, 3) Connect the proposed solution with your suspected*

positive and negative effects by cause-and-effect relationships, and 4) Read the negative branches from bottom up using if-then logic, scrutinizing every statement and logical connection along the way, and make necessary corrections (1997)." For example, if on-time delivery is a performance metric, then drivers may be forced to exceed the time allowed for consecutive driving hours in order to consistently meet on-time delivery. This process helps to identify trade-offs between the metrics.

In addition to the categorization of transportation company, we realize that proper categorization of performance metrics is crucial. Well categorized metrics reduce the chances of using the wrong metrics and make the proper understanding/analyzing of certain metrics possible. Kaplan and Norton (2001) create a performance metric framework known as the balanced scorecard. The balanced scorecard is a *"multifaceted tool for communications, alignment, improvement, and control that integrates critical non-financial performance measures into the basic management structure of the organization (1992)"*. According to the authors, the balanced scorecard *"retains measures of financial performance – the lagging outcome indicators- but supplements these with measures on the drivers, the lead indicators, of future financial performance (2000)"*. The framework was divided into four perspectives: customer, internal business, learning and growth, and financial (2000). The learning and growth perspective includes employee training and corporate cultural attitudes related to both individual and corporate self-improvement (2002). The internal business perspective refers to internal business processes. Performance metrics that are based on this perspective enable the managers to know the status of their business. Furthermore, the

metrics tell whether the products and services conform to customer requirements (2002). On the other hand, the customer perspective is based on the importance of customer satisfaction in all businesses (2002). Finally, the financial perspective is based on timely and accurate financial data from the management. By using balanced scorecard, we can categorized virtually all metrics into these perspective. According to Brewer and Speh (2000), this framework “*balances the inclination to overemphasize financial performance by incorporating metrics related to business process measures, innovation and learning measures, and customer satisfaction measures*”. In addition, Brewer and Speh developed a method that applied the balance scorecard to measure the performance of supply chain.

In the project, we integrated the four perspectives of Kaplan and Norton’s balanced scorecard into the metrics categorization. In other words, the performance metrics that we have identified for transportation providers within the on-line benchmarking system are classified according to balanced scorecard framework. Indeed, the integration of these perspectives into our categorization facilitate the understanding and dissemination of the metrics.

CHAPTER 3: METHODOLOGY

In order to satisfy our objectives, the following procedures were executed step by step:

- (1) Performance metric collection: We collected a total of seventy-nine performance metrics that were most related to the various operations of trucking service providers. All the metrics were categorized to the four balanced scorecard perspectives accordingly.
- (2) Identify information requirements: We identified the “tasks” that we needed to perform so that the objectives of this project could be fulfilled. In order to identify the information requirements, we utilized the Unified Modeling Language (See section 3.2.1 for more detail) to analyze the situation.
- (3) Implementation: After we had identified all the required tasks, we needed to implement the tasks. The implementation was mainly achieve by (i) creating a data-driven dynamic website, (ii) creating a relational database, and (iii) implementing an online decision tools based on the collected metrics known as “Simple Multi-Attribute Rating Techniques” or SMART.

3.1 Step One: Performance Metric Collection

A performance metric is an indicator of performance in a system. A metric may have a certain value and unit that measures and indicates the system performance. The importance of performance metrics in benchmarking is that the metrics highlight the important aspects of a system that can be improved. In other words, performance measurement evaluates performance relative to a defined goal. A benchmarking team may identify the performance metrics of a process so that a complete performance

measurement system can be designed. By improving the values of certain metrics, the performance of a system can be improved.

In order to facilitate online benchmarking, we need a comprehensive list of performance metrics in all areas of interest for transportation providers. In order to develop a comprehensive list of potential metrics, we examined literature related to trucking service providers and discussed metrics with experts within the industry. After identifying potential metrics, we categorized the metrics into the four categories associated with the balance scorecard. The grouping of metrics was subjectively based on their functionalities and properties. For instance, the “unloading time” metric was categorized into the “operational measures” group because “unloading time” was directly related to the time needed to unload goods in an operation.

By using the balanced scorecard groupings, we attempted to cover all the major operations within a company. In other words, the metrics collection is not meant to be a complete list of metrics, but to serve as a resourceful reference for transportation service providers (mainly for trucking service providers). The four groups of performance metrics covered the most important performance areas that can be improved in a company. For instance, if a manager wishes to improve customer relations, the manager can look into the “customer” group for useful metric(s). Similarly, the manager can look into other groups as needed.

As indicated in Table 1, the metrics are classified according to the categories in the balanced scorecard. The metric table is not rigid. In fact, one can add more metrics into the table so that the collection can be more comprehensive.

Internal Business Process	Financial Measures	Learning and growth	Customer
Loading size	Direct cost per truck	Absentee rate	Claims settling rate
Average length of haul	Maintenance cost /mile	Average # of workdays	% Of active customer
Average speed	Driver's gross pay	Driver's weekly work hours	Delivery accuracy
Operating hour/Truck/day	Operating Revenue/wages	Average nights a driver's home/week	% Correct order
%Distance driven empty	Revenue/driver	Training received	% Order returned
Trailer loading rate	Revenue/(Driving time)	Recognition	Delivery date compliance
Trailer unloading rate	Revenue/Trip	Accident rate	Re-purchase rate
Load Factor	Revenue/Truck	Availability rate	% Order on time
Miles/Truck/week	Operating Revenue/Distance	Education	Service termination rate
Average loaded miles	Revenue/Hour	Turnover rate	Claims rate
Average empty miles	Maintenance Cost	# Grievances/year	Complete order rate
# Stops per route	Logistics operating expenses	Recruitment rate	Damage free rate
% Routes repeated	% Return on asset	Truck operator's experience	On-time delivery
Average MPG	% Return on investment	# Truck operators	On-time order entry
Trailer, tractor ratio	Revenue growth rate	Employment opportunities/year	On-time loading
% Driven not empty	% Market share	% Offers accepted	Correct destination rate
Time driven between 2 stops	Rental Expenses	Promotion rate	Data Entry Accuracy
Tracking accuracy	Insurance expenses		
Inventory record accuracy	Annual inventory usage		
Pick rate	Inventory asset value		
Fill rate/Quantity	Operating revenue/year		
Material handling rate			
Inventory Turnover			
% Complete sales			
Loads/trailer/year			
Average # of dispatches/load			

Table 1: Performance Metrics

For each metric, we developed a detailed metric description that included a name, a textual description of the metric, a formula for computing the metric if applicable, the measurement units for the metric, the purpose of the metric, and a place for comments or discussion about the metric. The following is an example of such a description:

Name:	Loading Capacity
Definition:	Maximum load per trailer in tons
Formula:	N/A
Units:	Tons
Purpose:	Used to identify the loading capacity of trailers.
Discussion:	This metrics is needed to derive other metrics, such as “Average load of truck”.

Please refer to “Appendix A” for complete list of metric descriptions.

3.2 Step Two: Identify Information requirement

Before we can identify the information requirements, we need to understand the technical requirements of the project. Information requirements are the requirements of the project that one has to identify and satisfy so that the objectives of the project can be met. In order to identify the project requirements, we performed the following two tasks:

1. Examine system-user interaction through use cases.
2. Identify all major classes and attributes.

The following are the detailed descriptions of the tasks that we have performed.

3.2.1 Task one: Identification of Use Cases

Unified Modeling Language (UML)

Before we get into the discussion of use cases, we need to introduce the UML, which is the parent of use case. We utilized UML to develop the representation of information requirements. As defined by the Rational software company, the definition of UML is:

The Unified Modeling Language (UML) is a language for specifying, visualizing, constructing, and documenting the artifacts of software systems, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have

proven successful in the modeling of large and complex systems. (Source: www.rational.com)

In addition, UML provides the application modeling language for,

- Business process modeling with ‘use cases’.
- Class and object modeling.
- Component modeling.
- Distribution and deployment modeling.

(Source: www.rational.com)

Since UML is a powerful tool to model a problem, we utilize it to model our information requirements. In other words, UML helped us to identify all the requirements in this project so that we knew exactly what we wanted to build. By using UML, we identified all major classes and attributes in the project. In addition, we identified use cases of the system as well. In the following section, we will discuss use cases in detail.

As we have seen, use case is one of the components of UML. A UML use case can be used to show all the functionalities in a given system. A use case consists of four major elements:

- (i) **Actor:** An actor is anything that interacts with a system. It can be a human actor or non-human actor.
- (ii) **Definition:** The description of the user-system interaction

(iii) **Scenario:** If different scenarios exist in a use case. Then, list all possible scenarios.

(iv) **Use Case:** Name of the use case has to be defined

In this project, we brainstormed a list of possible uses of the online benchmarking system. Then, the list was further refined. The refinement was done in the way that only specific uses of the system that satisfied the objective requirements was allowed. The following is an example of a use case that describes the interaction of the user with the system. Please refer to Appendix E for the complete listing of use cases. Indeed, the use cases shown in Appendix E encompass most if not all of the possible uses and scenarios that might occur during system/user interactions.

Use Case: Take Survey

Definition: Surveys are available online so that users who are interested in participating in taking a survey can fill out an electronic survey form easily. The survey respondent has to go to a designated web page that contains the survey.

Actor: Transportation service provider (TSP) – Transportation service provider is the company that provides transportation service.

Scenarios:

Actor (TSP)	System
Click "Survey" link.	
	Display all surveys that are available in the system.
Select a survey by clicking on it.	
	Display the survey questions.
Fill out the questionnaire. Click "Submit" button after the user completed the questionnaire.	
	Perform error checking - If error is detected, display error message and ask user to correct the error. - Else, display message to thank the survey taker.

In the following, we discuss the important concept of classes and attributes that contribute to our database design.

3.2.2 Task Two: Identification of Classes and Attributes

Major classes and their corresponding attributes were identified. Classes describe the objects that we have to store in the system so that the system contains all the functionality stated in the use cases. Attributes are all the properties that are associated with classes. In the following, an example of the registered user class and its attribute are given. Please refer to Appendix F for all major classes and their attributes.

Class: Registered User

Description: A registered user is a person who registered online in the benchmarking website so that he/she can use some features in the website.

Attribute: First Name

Description: A name that describes the first name of the registered user.

Domain: A text string

Attribute: Last Name

Description: A name that describes the last name of the registered user.

Domain: A text string

Attribute: Company Name

Description: A name that describes the name of the company that the registered user currently works.

Domain: A text string

Attribute: Phone number

Description: A phone number is a text string of number that can be used to make a phone call. This is the phone number of the company that a registered user currently works.

Domain: An text string in the form ###-###-####

Attribute: Email address

Description: A user name and domain name that can be used to send or receive email.

Domain: A text string in the form UserName@DomainName

Attribute: User name

Description: A user name that is selected by the registered user as the login information and validation.

Domain: A text string or number or combination of both.

Attribute: password

Description: A string or number or combination of both that is selected by the registered user as the login validation and information.

Domain: A text string or number or combination of both

3.2.3 Class Diagram

After we had identified all the classes and attributes, a class diagram that indicates the relationship between the classes was drawn. Since the benchmarking website is a data driven website, we need a database to support it. Note that the class diagram served as an important guide to the fundamental design/structure of our database. The class diagram is shown below:

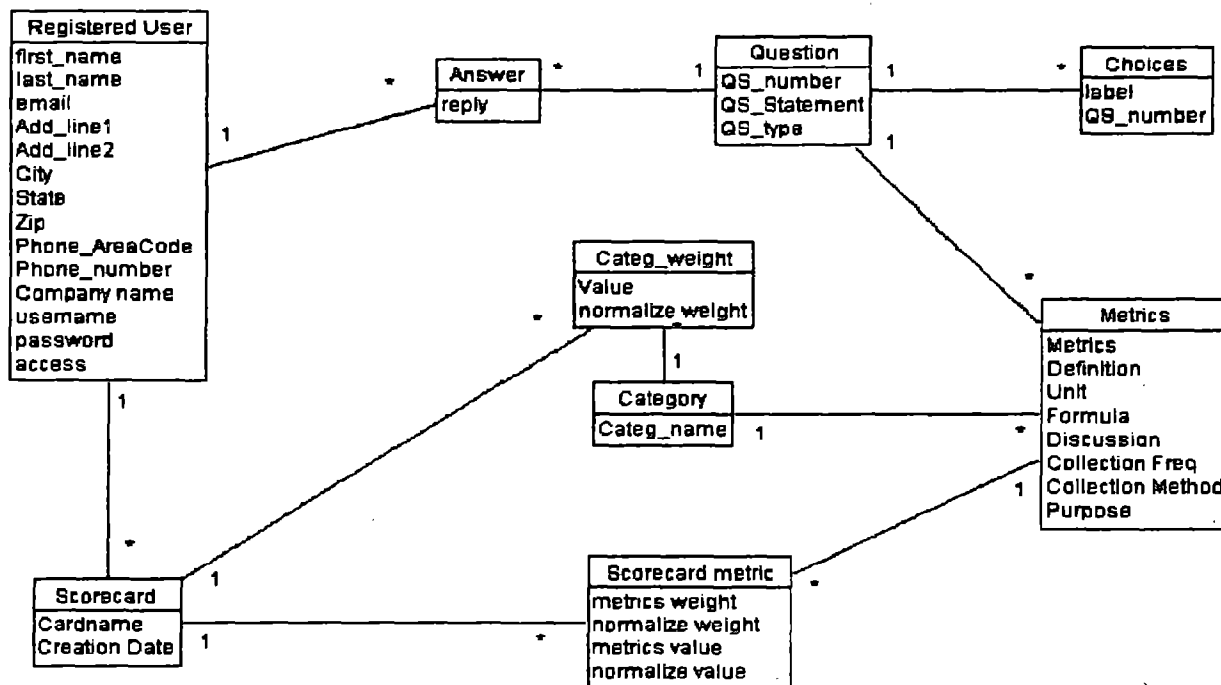


Figure 1: Class Diagram

Relationship Interpretation

The relationship between two distinct classes can be interpreted this way: The relationship between “Registered User” and “Scorecard” indicates that, a registered user can create many “scorecards”; however, an existing “scorecard” must belong to only one “registered user” only. The relationship between “Question” and “Answer” implies that, one question can have one or many answers; however, each answer belongs to one question only. The other relationships can be interpreted in a similar manner.

3.2.3 Information Requirements

After a careful analysis of all the use cases and classes and their attributes, we concluded the information requirements of the project, which were shown in the following:

- 1) *Web Interface*: This is the only interface that a user can interact with the system anywhere in the world where an Internet connection is available. The web interface is built by using the latest web technology known as Active Server Pages (ASP) and Hyper Text Markup Language (html) version 4.0. Also, a software known as “Dreamweaver Ultra Dev 4.0” by Macromedia is used as the programming and development platform.
- 2) *Relational Database*: A relational database was built based on the class diagram so that data (performance metrics, user information, question, etc.) could be stored. We use the database to support our website so that web interface can be used to collect and display information. If the traffic to the web page and the

utilization of the system are both high, we gave a good chance of having many transportation providers as the system users. Thus, the database will integrate the interests of many transportation providers, who are interested in benchmarking.

After the information requirements were identified, we began our implementation.

3.3 Step three: Implementation

The implementation of the system is mainly divided into three parts, which are the (i) Relational database design, and (ii) Web interface and (iii) Online performance analysis application based on SMART. In the following, we start our discussion by elaborating on the design of our database.

3.3.1 Part One: Relational Database Design

Andersen (1999) defines a database as an “organized collection of objects that is used to store, manipulate, and retrieve data for a specific purpose.” In the project, we used the relational database model that was first developed by Dr. E.F. Codd in 1970. The flexibility of the relational model contributes to the development of many database software packages that are available today, such as Microsoft Access, Oracle, SQL server, DB2, and Informix. In a relational database, data is stored in “tables” and the logical stored form of data is known as “record”. A table is made up of two elements, which are “records” and “fields”. “Record”, as we have mentioned earlier, is a logical stored form of data. Each information or data in a record belong to at least one “field”. For example, a metric’s record may consist of several fields, which are “metric name” and “property” and “definition”. Then, the information or data under “metric name” may

be “Loading size”. On the other hand, the information or data under “property” may be “hi”. In each record, a metric can be identified by a unique identifier, known as “primary key”. In Figure 2, we set “PM ID” as our primary key in this table. Note that every table has to have one and only one unique primary key. The powerful aspect of the primary key is that it can be used to cross reference information that is stored in other tables in the same database.

Primary Key **Field**

PM ID	QS ID	Categ ID	MeName	property	Definition
1	43		2 Loading size	hi	The physical load size of a loaded trailer
2	45		2 Average length of haul	lo	The average length of line haul, which is the length of distance
3	46		2 Average speed	hi	Average speeds during line haul operation
4	46		2 Operating hour/Truck/year	hi	Average operating hour of truck per year
5			2 %distance driven empty	hi	Percentage of distance that is driven with empty trailer during
6	46		2 Trailer loading rate	hi	# of trailer that is loaded with pallet of goods or per unit time
7	51		3 claims settling rate	hi	# of days that is needed to settle one claim
8			3 % of active customer	hi	Percentage of customers that maintain an active account with
9			3 Delivery accuracy	hi	Accuracy of delivering a goods to a correct destination
10			3 % correct order	hi	Percentage of orders that is taken correctly
11			4 MTNC cost Ampe	lo	The cost of fleet maintenance per mile
12			4 Operating Revenue/wages	hi	The ratio of operating revenues to wages of drivers
13			4 Operating Revenue/distance	hi	The ratio of operating revenues to length of line haul
14			5 Absence rate	lo	The ratio of employee absent day to total # of work day in a
15			5 average # of workdays	hi	Average number of work days in a typical month
16			5 Accident rate	lo	Number of workday lost due to accident
17			2 Load factor	hi	The ratio of average load to load capacity
18			2 Miles/Truck/week	hi	The average number of miles traveled by a truck per week
19			2 Average loaded miles	hi	The average number of miles driven with loaded trailer
20			2 Average empty miles	lo	The average number of miles driven with empty trailer
21	46		2 # of stop per route	lo	The average number of stops that a driver made due to break
22	52		2 % route repeated	hi	Percentage of route repeated regularly by a driver
23			2 Average fuel economy	hi	Average miles per gallon of a truck
24			2 Trailer/trailer ratio	hi	The ratio of # of trailer to # of truck

Record **Data/Information**

Figure 2. Database Table

A relational database enables us to use “Structure Query Language (SQL)” to extract information that we needed from the table(s). By using SQL, we can construct any logical query as needed so that data can be retrieved and used for our purposes.

Benchmarking Database: Our Database

By using Microsoft Access, we created nine tables and defined the relationships among the tables. Tables are related so that we can create queries as needed to retrieve, store, and manipulate data. Figure 3 showed the architecture of the database with simplified table structure. Based on the design of the class diagram (Figure 1), the nine tables captured all the major elements as shown in the diagram. The lines that link the tables represent the relationship. By drawing a line between two tables, a relationship is defined. Note that we can interpret the relationships in the similar fashion as in the relationship interpretation within the class diagram.

As shown in the table, the name of the table is highlighted in gray. The fields of tables are listed below the table name. Note that the primary key of each table is highlight with “bold” text style.

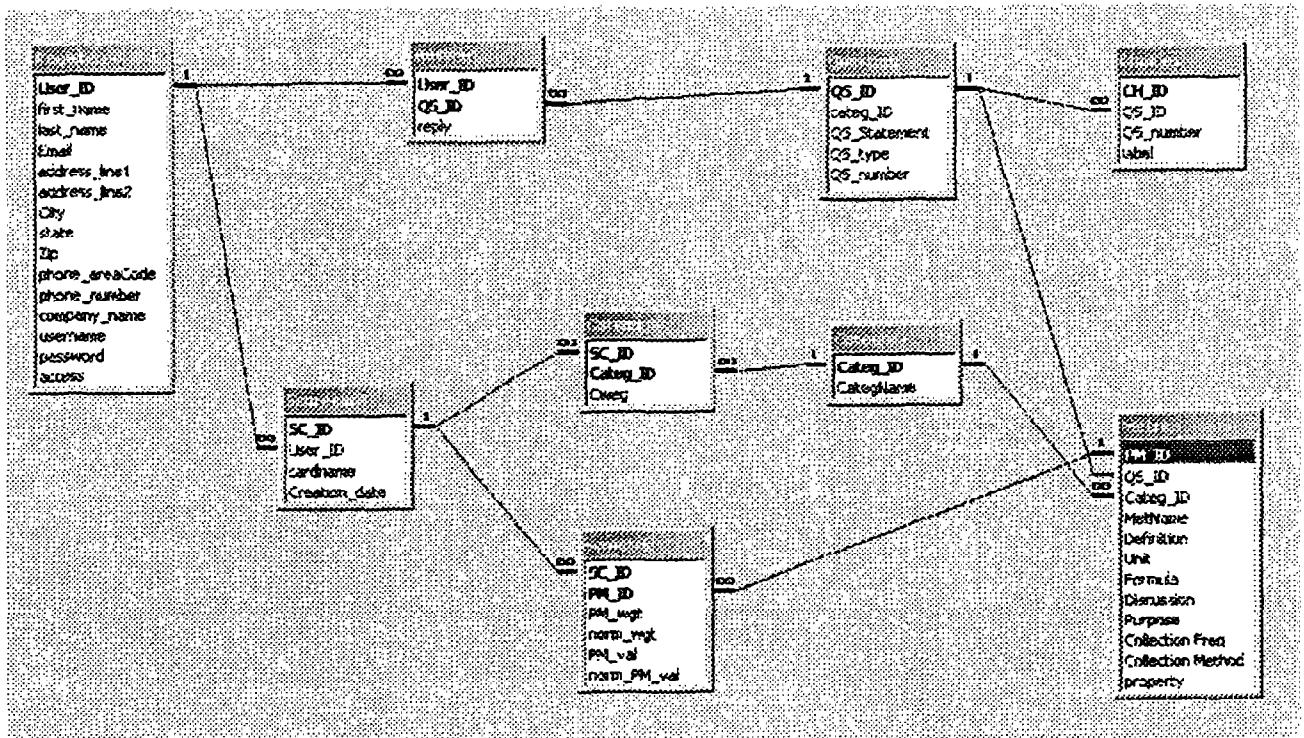


Figure 3. Database Structure

As we have seen, Figure 3 showed the architecture of the database. However, the database is empty with no data at this point. In the following, we discuss the data collection of performance metrics so that the data can be used to populate the database.

Performance Metric Data Collection

In order to collect the data needed for the online analysis tools, we created online surveys so that performance data can be collected. The questionnaire was designed by referring to the performance metric list. The questions were mainly designed to obtain values for all the metrics in the list. The surveys were divided into five categories, which were “Carrier Categorization”, “Customer Perspective”, “Internal Business Perspective”, “Learning and Growth Perspective”, and “Financial Perspective”. Note that in addition to the four balance scorecard groups, “Carrier Categorization” was added to the survey so

that an accurate type of carrier can be recognized. For example, a trucking company may be categorized as a less than truckload and regular-route carrier, who delivers hazardous material only. The following is a question taken from the Internal Business Process Survey (Appendix B).

Q12. What is your total mileage operated in intercity service annually?

Loaded Miles

Empty Miles

Additional questions were formatted for each performance metric. A complete list of survey questions can be found in Appendix B. Before we proceeded with a general survey of transportation providers, we wanted to ensure that we were asking the right questions. Therefore, we requested the assistance of transportation companies. We contacted the companies that were interested in the evaluation process and sent them an evaluation package. There were approximately 60 questions to review. We estimated that it would take one to two hours to review and comment on the survey.

The review of the questionnaire involved examining the survey from a transportation provider's perspective and commenting on:

- (i) Whether or not the question makes sense (categorized correctly with wording that is understandable to transportation professionals)
- (ii) The level of difficulty in gathering the data required for the questions.
- (iii) The importance of the questions to transportation providers.

The questionnaire was reviewed by three experts in industry associated with WalMart, J. B. Hunt Transport, and ABF Freight System Inc. Please refer to Appendix D for the results of the industry evaluation on the questionnaire.

By using standardized evaluation form, feedback was collected and improvements or clarifications were made to the questionnaire. The following is an example of the evaluation questions on the evaluation form:

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who?)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

The final version of the questionnaire is hosted on the website and available to the general public. In fact, responses to the survey are very important. If sufficient responses are received from the public, we will be able to ensure the successful implementation of the application based on SMART. Specifically, participation in the survey process can yield the following benefits:

- 1) Accurate and representative performance analysis based on SMART: Online surveys collect performance data from the users. In turn, sufficient performance

data ensures that the performance analysis will involve most participants of the surveys. Therefore, the result of the performance analysis will be more representative and accurate.

- 2) Identification of benchmarking partner(s): Participation in the survey contributes to the amount of performance data. A sufficient amount of available data improves the chances of identifying a suitable benchmarking candidate through the use of SMART based performance analysis.
- 3) Through the use of the website, the surveys are the essential tool that contributes to the dissemination of benchmarking knowledge and practices. In other words, if performance data is sufficient, many may be drawn to the site for benchmarking related information. Eventually, the website may become a tool to disseminate benchmarking practices.

In the following, we discuss Part Two, which is the implementation of the web interface.

3.3.2 Part Two: Introduction to Online Benchmarking System: The Web Interface

The website/interface was built by using both Internet scripting and programming tools, known as “Hyper Text Markup Language 4.0 (html)” and “Active Server Pages 2.0 (ASP)”. The following Figure 4 shows the homepage of the website.

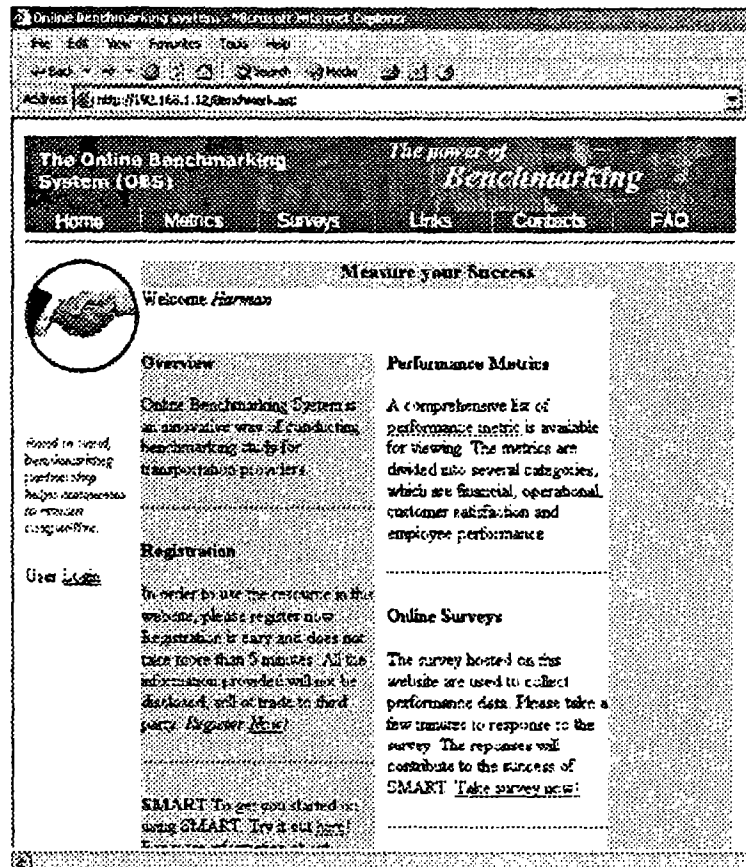


Figure 4. Online Benchmarking Homepage

Further examples of the website pages are documented in Appendix G. From the homepage, a user can explore the resources provided in the page by clicking on the highlighted links. For example, a user can login, view performance metrics or participate in the surveys. The following flow diagram illustrates the structure and flow of the website.

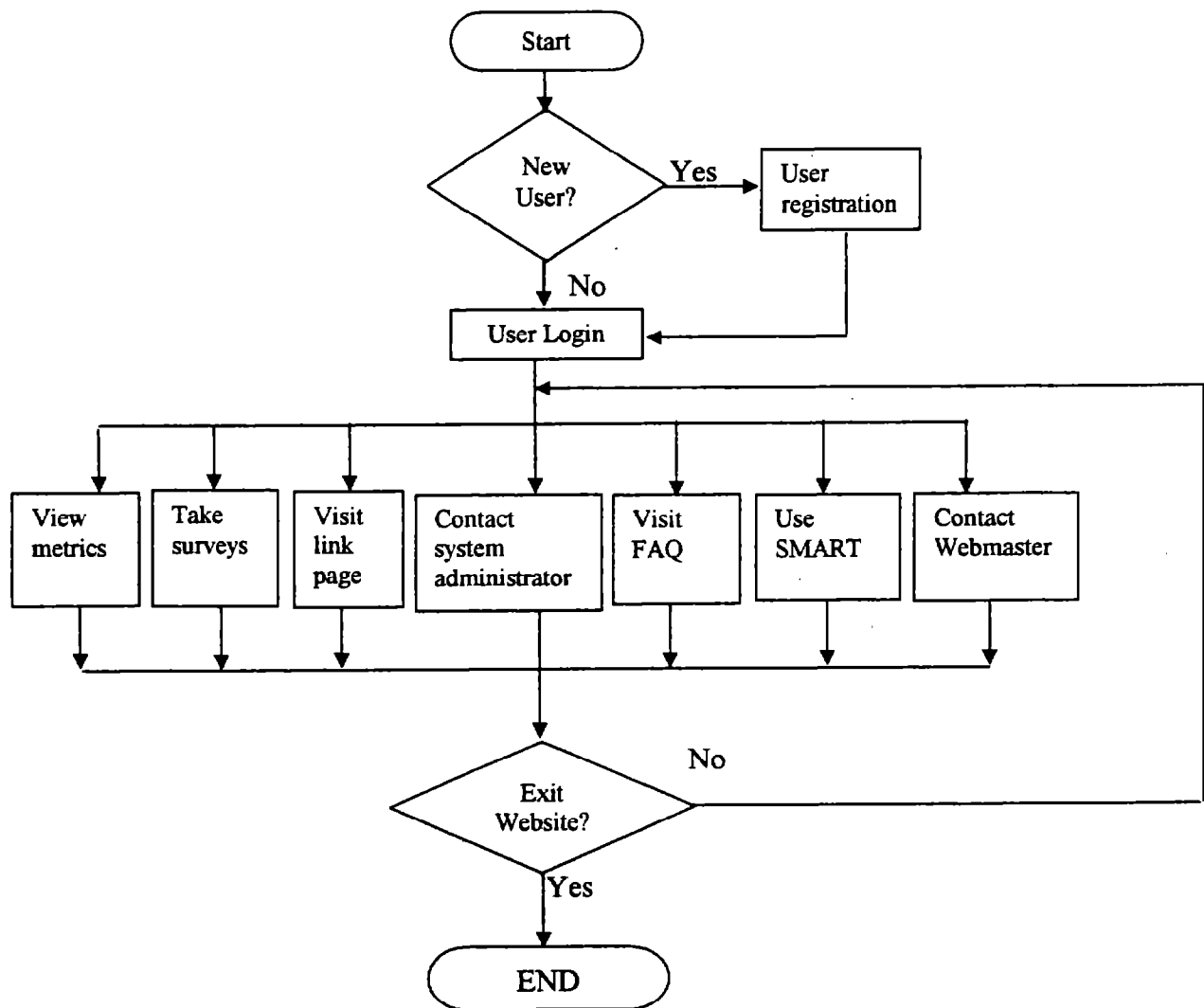


Figure 5. Online Benchmarking System Structure

A new user has to register in order to gain access to web application resources such as the performance analysis based on SMART and surveys. Specifically, the user must provide “last name”, “first name”, “email address”, “username” and “password” in order to register. In addition, we included user’s contact address and phone number in the registration page; however, contact address and phone number are not necessary for registration.

Before one can use the system, the user has to login. After the user has logged in, he/she has full access to all the resources available in the website. For example, the user can take surveys or perform a performance analysis based on SMART. Then, the user can either stay in the website (to access more resources) or exit the website. Since the benchmarking system requires the enabling and tracking of cookies, all the sensitive information will be immediately destroyed once the user exits the website. In this case, the sensitive information is limited to username and password only. More information about the website and its code can be found in documentation of Chapter 4.

3.3.3 Performance Analysis Based on SMART

Transportation providers may be interested in comparing their performance to other providers by using the system. The online system provides an application that allows a trucking service provider to compare itself against others in terms of overall performance. The method of comparison is based on the method known as SMART method or “Simple Multi-Attribute Rating Techniques”. SMART is a rating technique that is capable of handling more than one attribute. The method requires the user to assign weights to attributes and calculations are performed to determine the overall “aggregate performance” of a company. The higher the value of aggregate performance, the better the performance of a company. The method based on SMART consists of the following two steps: 1) Identification of crucial performance indicators, and 2) Multi-criteria rating and ranking. In the following, we will discuss the two steps in detail.

Step1. Identification of crucial performance indicators

After all the necessary metrics are collected, we have enough attributes to perform analysis of performance. Note that *not all* metrics need to be used in the analysis. There are two reasons why we want to use a limited number of metrics:

- a) Practicality: It may not be practical to use all the metrics because some companies simply do not collect the metrics.
- b) Complexity: Having too many metrics increases the complexity, time and effort of the performance analysis by making it more difficult to assign and interpret weights.

During the process, the user provides performance data for the metrics and rates the metrics. Due to the diversity of trucking companies (e.g. truckload, less than truckload, regular route carrier, private carrier, etc.), some companies may consider different performance metrics as crucial in indicating their performance. Therefore, the metrics can be dynamically changed according to a company's preference or situation. In the website, we allow the user to determine his/her own critical metrics (or attributes).

Step 2. Multi-criteria rating and ranking

There are two elements in this steps, which are (i) Swing Weight Assignment, and (ii) performance calculations. In the following, we will discuss each elements in details.

(i) Swing Weight Assignment

Swing weight:

The swing weight is a special weight to apply to a metric. In order to illustrate the concept of swing weight, the following imaginative scenario is used.

Scenario:

John is a CEO of an air conditioning company who needs to expand the company's production capacity by building another manufacturing plant in Arkansas. He has the following locations in mind, which are Fayetteville, Fort Smith, and Little Rock. Therefore, he needs to make a decision on which location is the best choice. In order to make the decision, he has a meeting with the executive managers. After the meeting is concluded, they decided to use the following metric as the selection criteria:

- (1) Proximity: The average distance of the manufacturing facility to the nearest location of customer.
- (2) Transportation convenience: The average distance of the facility to the closest distribution center.
- (3) Size: The size limit of the facility in each location.

John decided to use SMART analysis to figure out the location problem. However, he does not know exactly how to assign swing weights to the three metrics. Therefore, an external consultant, Sam, is hired to advise on this matter. Sam starts by asking John to rank the importance of the three metrics. Specifically, if just one of these metrics could be moved to its best level, which metric would John choose? In this case, John selects "Proximity". After the change has been made, Sam continues to ask John to rank the other two metrics based on the respective importance. John's rankings are:

- 1) Proximity (most important)
- 2) Size
- 3) Transportation convenience (least important)

Now, Sam assigns a weight of “100” to the most important metric, which is “proximity. The other weights are assessed as follows. John is asked to compare a swing from the smallest facility size to the biggest, with a swing from the most distant location from customers to the closest location (proximity). After a careful consideration, John decides that the swing in “size” is 90% as important as the swing in “proximity”. Therefore, “size” is given a weight of 90. Similarly, a swing from the worst “transportation convenience” to the best is considered to be 80% as important as a swing from the furthest to the closest customer location for “proximity”, so “transportation convenience” is assigned a weight of 80. As a result, the swing weights for “proximity”, “size” and “transportation convenience” are 100, 90 and 80 respectively.

In order to summarize the swing weight assignment, we present a general guideline to assign swing weight in the following.

Swing weight assignment guide

After the performance metrics have been selected for performance analysis, the user must assign a value and a “swing weight” to each individual metric. In order to apply swing weights to metrics, we follow the following guidelines:

- (1) Rank the “importance” of the metrics in descending or ascending order.
- (2) Assign a weight of “100” to the most important metric.
- (3) Assign a swing weight to the second most important metric by comparing the current metric with the previous metric (which is the most important metric). For example, the second metric may be 90% as important as the first metric. Therefore, the swing weight of the second metric is “90”.

- (4) Similarly, the assignment of swing weight to the third important metric and the rest of the metrics can be determined by comparing them to the most important metric.

After the “swing weight” and value of metrics have been assigned, we perform the usual SMART calculation.

(ii) Performance calculations

The calculations can be divided into two parts, which are, (a) determine the value function of each attribute, and (b) determine the aggregate performance of each alternative. In the following, we will discuss each part in details.

- a) *Determine the value function of each attribute*: In this prototype, all the value functions were estimated by assuming a linear relationship. A linear function is used for simplicity and the linearity does not imply a specific preference structure. The linear relationship is found by taking the maximum value of metric and minimum value of metric from the database. For instance, we may take the maximum and minimum value of “on time delivery” from the database. Then, a linear equation is found by using the maximum and minimum value. In the following, we describe the process to find the linear relationship.

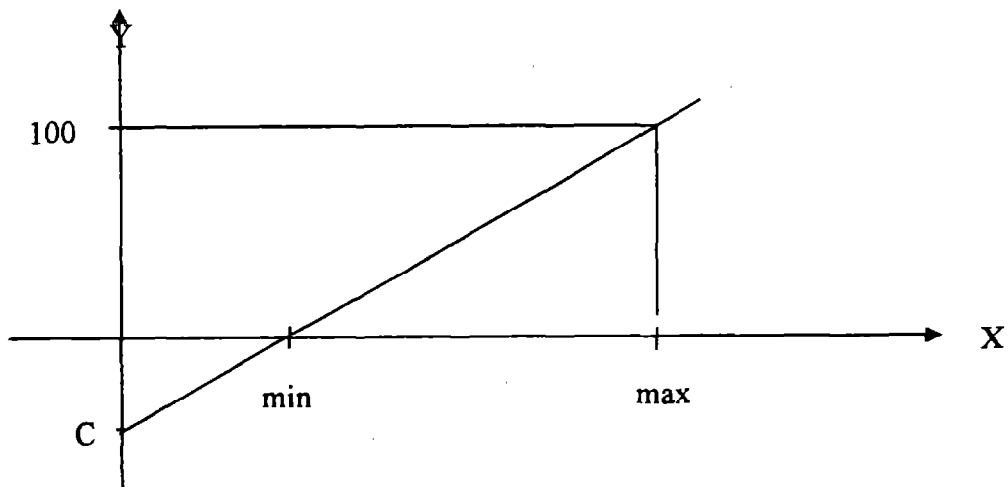


Figure 6. Value function of a metric (that preferably has its value maximized)

Figure 6 shows a typical linear value function of a metric. Note that this relationship only applies to those metrics that preferably have their values maximized. For example, if we want to maximize the value of “market share”, then, this type of value function can be used. In the following, we derive the general expression of linear value function.

Let y =mapped metrics value

x =Original metric value

\max = Upper bound, or the maximum value of a metric

\min = Lower bound, or the minimum value of a metric

Linear relationship:

$$y = mx + C \quad (1)$$

Where,

$$m = \frac{100}{(\max - \min)} \quad (2)$$

From (1), we derive C ,

$$C = y - mx \quad (3)$$

Substitute $X = \max$, $Y = 100$ into (3), yields

$$C = 100 - m * \max \quad (4)$$

Substitute (2), (4) into (1), therefore,

$$y = 100 * \frac{x}{(\max - \min)} + 100 - m * \max \quad (5)$$

Equation (5) is the general expression of metric value function. It is used to convert metrics that prefer to be maximized on the range of “0” to “100”.

On the other hand, Figure 7 shows a typical linear value function of a metric, which relationship only applies to those metrics that preferably have their values minimized. For example, if we want to minimize the value of “% distance driven empty”, then this type of value function can be used. In the following, we derive the general expression of linear value function.

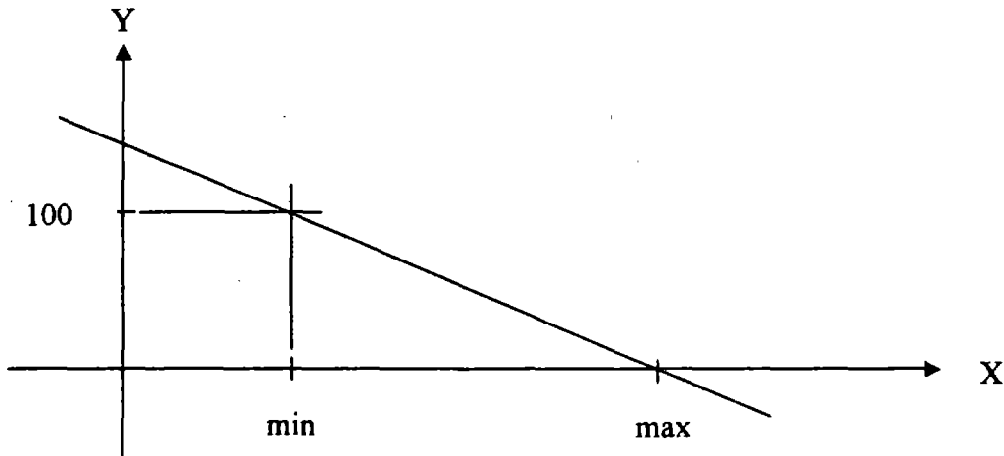


Figure 7. Value function of a metric(that preferably has its value minimized)

Linear relationship:

$$y = mx + C \quad (6)$$

Where,

$$m = \frac{-100}{(\max - \min)} \quad (7)$$

$$C=y-mx \quad (8)$$

Substitute $x=\max$, $y=0$ into (8), yields,

$$C= - m(\max) \quad (9)$$

Substitute (7), (9) into (6), therefore,

$$y= -100 * \frac{x}{(\max - \min)} - m * \max \quad (10)$$

Equation (10) is used to convert metrics that prefer to have their values minimized on the range of “0” to “100”.

After the value function of each metric has been determined, we can determine the aggregate performance of each company.

b) *Determine the aggregate performance of each alternative:* The aggregate performance of trucking companies (i.e. alternatives) can be computed at this step. The largest aggregate performance value indicates the best overall performer. The following is the general expression of aggregate performance.

$$\text{Aggregate performance} = \text{AP} = \frac{\sum_{i=1}^n nw_i * y_i}{100} \quad (11)$$

Where nw =normalized weight
 n = number of metrics

In the online application, all the users who have the same set of metrics as those selected by the current user will have their aggregate performance calculated. For example, the calculations (for other users) will apply the swing weights assigned by the current user, based on the assumption that the current user is more interested in his/her own weighting

system. Therefore, the approach of this method depends on the likelihood of different users having matching metrics.

In order to facilitate the “understanding” of SMART based system, the following example illustrates the mechanism of such system.

Example 3.1. In this example, we have a simple scenario: A SMART based system that only has two users (John and Jack). In this case, John tries to use the system to compare the performance of his company to his competitor’s (Jack). In other words, John is the current active user of the system, who tries to determine his company’s performance status against the competitor. Note that, incidentally, Jack’s metric profile matches John’s. Assumptions (1) both users understand the mechanism of SMART, (2) the database was populated with numerous performance data, even if there are only two system users.

Solution:

Current User: John

The user selected the following metrics and assigned both value and swing weight to each of the metrics. In John’s case, he ranked the three metrics according to their respective importance in descending order. As shown in the table below, John ranked “complaint rate” as the most important metric and “length if haul” as the least important metric. In addition, the “preference” in the following table indicates that the metric prefers to be either “maximized (max)” or “minimized (min)”.

Selected Metrics	Preference	Metric Value	Swing Weight Assigned
Complaints rate	min	20%	100%
Delivery date compliance	max	95%	90%
Length of haul	min	500 miles	75%

Table2. John's metrics profile

Note: In the SMART based application, we created an interface in the website so that a user can assign swing weights to the selected metrics; however, a user must be familiar with the meaning of swing weights so that the weight can be assigned correctly. In addition, we provided an interface to the user so that a metric's value could be assigned and recorded.

Other User: Jack

Jack was the user who incidentally selected the metrics that matches the metric profile of John.

Note: In the online performance analysis based on SMART, all user information is stored in the database. Therefore, we always check if there are any matching metric profiles in the database before the calculations execute. If there are no matching profiles available, we will terminate the application and inform the user about the situation.

In order to calculate the aggregate performance for Jack, we use John's swing weight and impose it on Jack's because John (current user) is more interested in comparing his aggregate performance with Jack's by using his own weights. In other words, we always

impose the current user's weight on other users' metric profile (that matches the current user's metric profile). Table below shows John imposes his metric weights to Jack's.

Selected Metrics	Metric Value	Original Swing weight	Imposed swing weight
Complaints rate	10%	100%	100%
Delivery date compliance	85%	80%	90%
Length of haul	300 miles	60%	75%

Table 3. Jon imposes his metric profile onto Jack's.

Aggregate Performance

Before we can calculate the aggregate performance of both users, we need to determine the value function for all the metrics. The value function equation is obtained by deriving the linear relationship of x and y .

Metric value range= the maximum and minimum value of a specific metric that is currently available in the database.

Thus,

Metric value range: 0% to 100% (complaints rate)

Assign a weight of "100" for 0% complaints rate, and a weight of "0" for 100% complaints rate.

$\max=100$, $\min=0$, $m=-1$, $C=100$

Applying (10), the value function of "complaints rate" is $y=-x+100$

Metric value range: 0% to 100% (delivery date compliance)

Assign a weight of "100" for 100% delivery date compliance, and a weight of "0" for 0% delivery date compliance.

$\max=100$, $\min=0$, $m=1$, $C=0$

Applying (5), the value function of "Delivery compliance date" is $y=x$

Metric value range: 100 miles to 1000 miles (Length of haul)

Assign a swing weight of “100” for length under 100 miles, and a swing weight of “0” for length over 1000 miles.

max=1000, min=100, C=111.111

Applying (10), the value function of “Length of Haul” is $y = \frac{-1}{9}x + 111.111$

Then, we calculate the aggregate performance for both users:

John’s Aggregate Performance (Current user):

First, we normalize the swing weight.

Metrics	Swing Weight	Normalized Weight (nw)
Complaints rate	100%	37.7
Delivery date compliance	90%	33.9
Length of haul	75%	28.4

Table 4. John’s swing weight normalization

Second, we map each metric’s value by using the value function.

Metrics	Original Value	Mapped Value (mv)
Complaints rate	20%	80
Delivery date compliance	95%	95
Length of haul	500 miles	55

Table 5. John’s metric value mapping

Applying (11), $AP_{John} = (37.7*80 + 33.9*95 + 28.4*55)/100 = 77.985$

Jack’s Aggregate performance (other users):

First, we normalize the swing weight. Note that we impose current user’s weight to John’s.

Metrics	Swing Weight	Normalized weight (nw)
Complaints rate	100%	37.7
Delivery date compliance	90%	33.9
Length of haul	75%	28.4

Table 6. Jack’s swing weight normalization

Second, we map each metric's value by using the value function.

Metrics	Original Value	Mapped Value (mv)
Complaints rate	10%	90
Delivery date compliance	85%	85
Length of haul	300 miles	78

Table 7. Jack's metric value normalization

Applying (11), $AP_{Jack} = (37.7 \cdot 90 + 33.9 \cdot 85 + 28.4 \cdot 78) / 100 = 84.89$

Note that the value of aggregate performance of a company is directly related to the performance of the company. In this example, Jack's company has a greater aggregate performance than John's company. Therefore, we concluded that Jack's company has been performing better than John's company. By looking into the detail of the analysis, we notice that Jack's company has a much higher value of "complaints rate" than John's company. In addition, the assigned swing weight is 100% for "complaints rate". Therefore, the aggregate performance of Jack's company is higher than John's company. In order to improve the performance of John's company, John may focus on improving the value of "complaints rate", which has the highest impact on the overall performance. The following chapter discusses the website documentation in detail.

CHAPTER 4: WEBSITE DOCUMENTATION

4.1 Purpose of documentation

The main purpose of the website documentation is to facilitate website improvement and modification. Since the website is built by the current Webmaster, the lack of proper website documentation may impose difficult website management task for future web administrator. Indeed, the main audience of this documentation is aimed at the future web administrator who is interested in maintaining website. Thus, the documentation will describe mainly the code or programming aspect of the website. The following knowledge is highly preferable for anyone who wishes to continually maintain and upgrade the website.

4.2 What you need to know

The following knowledge is helpful for maintaining the website:

- 1) Basic programming skill is required
- 2) Knowledge of Active Server Pages is required
- 3) Knowledge of HTML 4.0 is required
- 4) Knowledge of Structured Query Language (SQL) is highly desirable
- 5) Knowledge of Vbscript is highly desirable
- 6) Basic Client/Server concept is desirable
- 7) Knowledge of any database management system
- 8) Knowledge of Dreamweaver Ultra Dev 4 is preferable.

In the following, we will discuss the ASP code that we used to built the website.

4.3 ASP Code Structure:

Application: SMART

Filename: SM_S0.asp

The following code is an excerpt of the web page that is written with both html and asp.

The web page is the first page that one will see if the user decided to use the SMART based application. This program can be divided into two parts:

In the first part, the program checks if "hid_check"=true, then carries out the process. Note that the value of "hid_check" is null the first time the program run. Therefore, nothing will be processed in this case and the program ignores the first part. However, when the program proceeds to run to second part, "hid_check" is set to "true" (see the code in bold). When user presses submit, the web page submits (value of hid_check" is submitted) to itself and the program re-runs. However, this time the value of "hid_check" is true so the code in first part is triggered and starts running. As we can see in first part, a user may be redirected to "newcard.asp" or "SM_S2.asp", depend on the situation.

'First part

<%

If request.form("hid_check")="true" then 'Check the flag

 If request.form("chx_newcard")="new" then

 response.redirect ("newcard.asp")

 end if

 'response.write (request.form("hid_count"))

 if request.form("rd_SC_ID")<>" " then

 session("scid")=cint(request.form("rd_SC_ID"))

 response.redirect ("SM_S2.asp")

 end if

end if

%>

'Second part

```
<form name="form1" method="post" action="SM_S0.asp">
  <table width="95%" border="1">
    <tr>
      <td width="27%"><b>New Scorecard</b></td>
      <td width="70%">
        <input type="checkbox" name="chx_newcard" value="new">
        Create a new scorecard</td>
      <p></p>
    </tr>
    <tr>
      <td width="27%"><b>Existed Scorecard</b></td>
      <td width="70%">
        <%
          If session("scid")="" then
            response.write "No record available"
          Else
            while Not rs_scorecard.EOF
              <%
                <input type="radio" name="<%=rd_SC_ID"%>"
                value="<%=rs_scorecard("SC_ID")%>">

                <% response.write rs_scorecard("cardname") & " " & rs_scorecard("Creation_date")&
                "<br>"
                rs_scorecard.movenext
              wend
            End if
          <%
            <input type="hidden" name="hid_check" value="true"> 'This is a flag
          </td>

        </table>
      <p>
        <input type="submit" name="Submit" value="Submit">
      </p>
    </form>
```

Above scenario is very common in Client/Server development. It is very important that the Webmaster understands and masters this technique. Generally, the technique can be represented in the following Diagram.

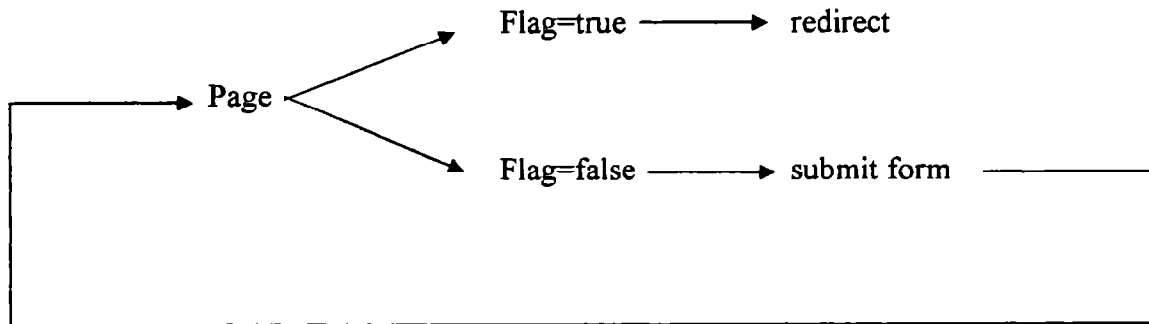


Diagram 1. Code Structure

(Diagram taken from “Foundation Dreamweaver Ultra Dev 4” by Paddock R. et al., pg 75)

The file “SM_S0.asp” will produce the web page similar to the following Figure:

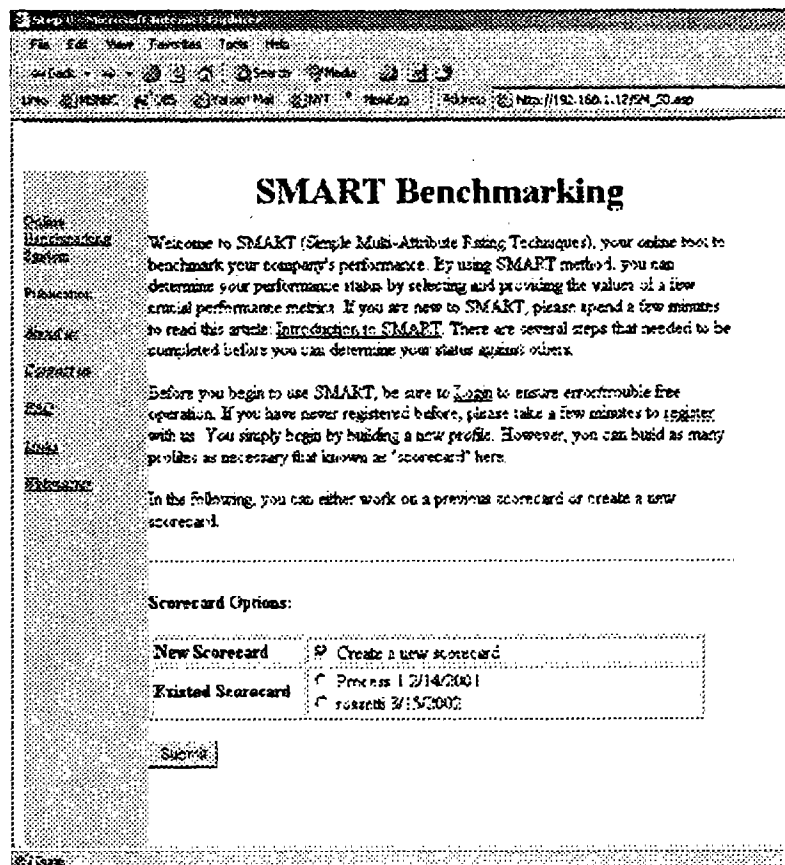


Figure 8. Web page produced by SM_S0.asp

All the SMART based application web files are structured in the similar manner. The files that associated with SMART based application are listed in the following:

SM_S0.asp: The homepage of SMART. In this page, we can create, delete or edit a scorecard

SMART.asp: In this page, we can select the metrics that we wish to include in our scorecard.

SM_S1.asp: In this page, all the previously selected metrics are displayed. In addition, the user is given the option of deleting or adding additional metrics.

SM_S2.asp: In this page, the user can assign metric values and swing weights to the selected metrics.

SM_S3.asp: In this page, we can assign weights to each metric category

SM_S4.asp: In this page, the aggregate benefit is calculated and result is displayed.

The following files are used to display the error message an once error is detected in the application files:

err_noblink.asp: Error message is displayed if a user tries to submit an empty form.

err_numeric.asp: Error message is displayed if a user tries to enter a non numeric data into a specific text box.

err_login.asp: Error message is displayed if user tries to access a restricted web page.

err_nomatch.asp: Error message is displayed if there is no user in our database that has the same metrics that the current user has selected.

4.4 A walkthrough of Online SMART Application

Online SMART application can be accessed from the home page of online benchmarking system (OBS). Figure 7 show the home page of OBS.

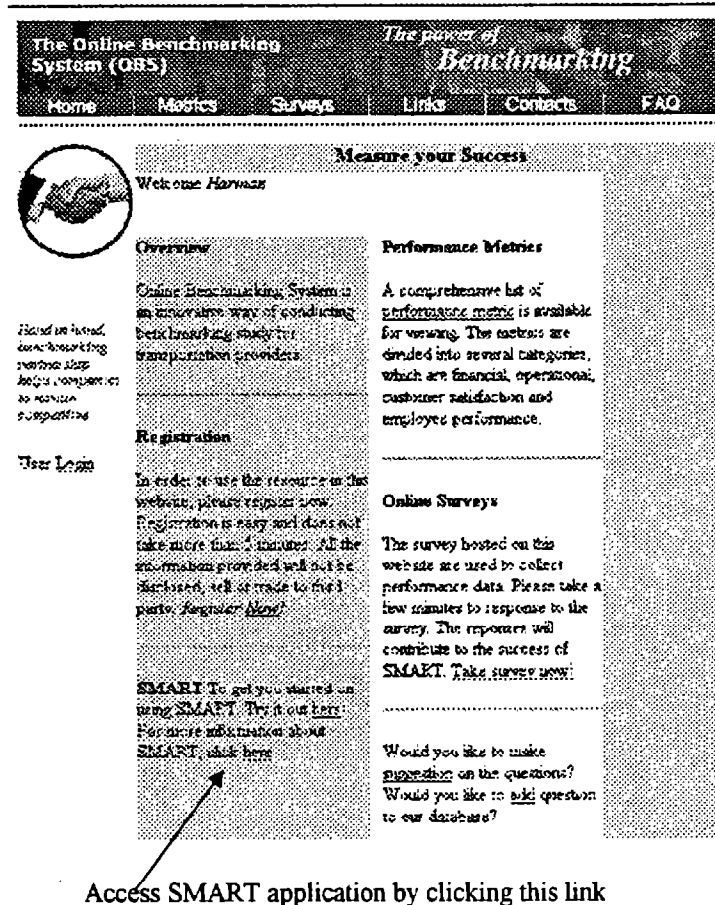


Figure 9. Home page of OBS

Note that one has to login in order to use the SMART application because the application requires the identification of every user so that a metrics profile or scorecard can be created and stored in the database. If the user has no user name, then he/she must register so that the user can create a user name and password. Once logged in, the system will automatically assign a user id for the current user. Note that the user id has been created and stored in the database when the user registers with the system. In the ASP code, the

value of the user id for the current user is stored in the session variable "session("userid")". Figure 8 shows the flows of the SMART based application.

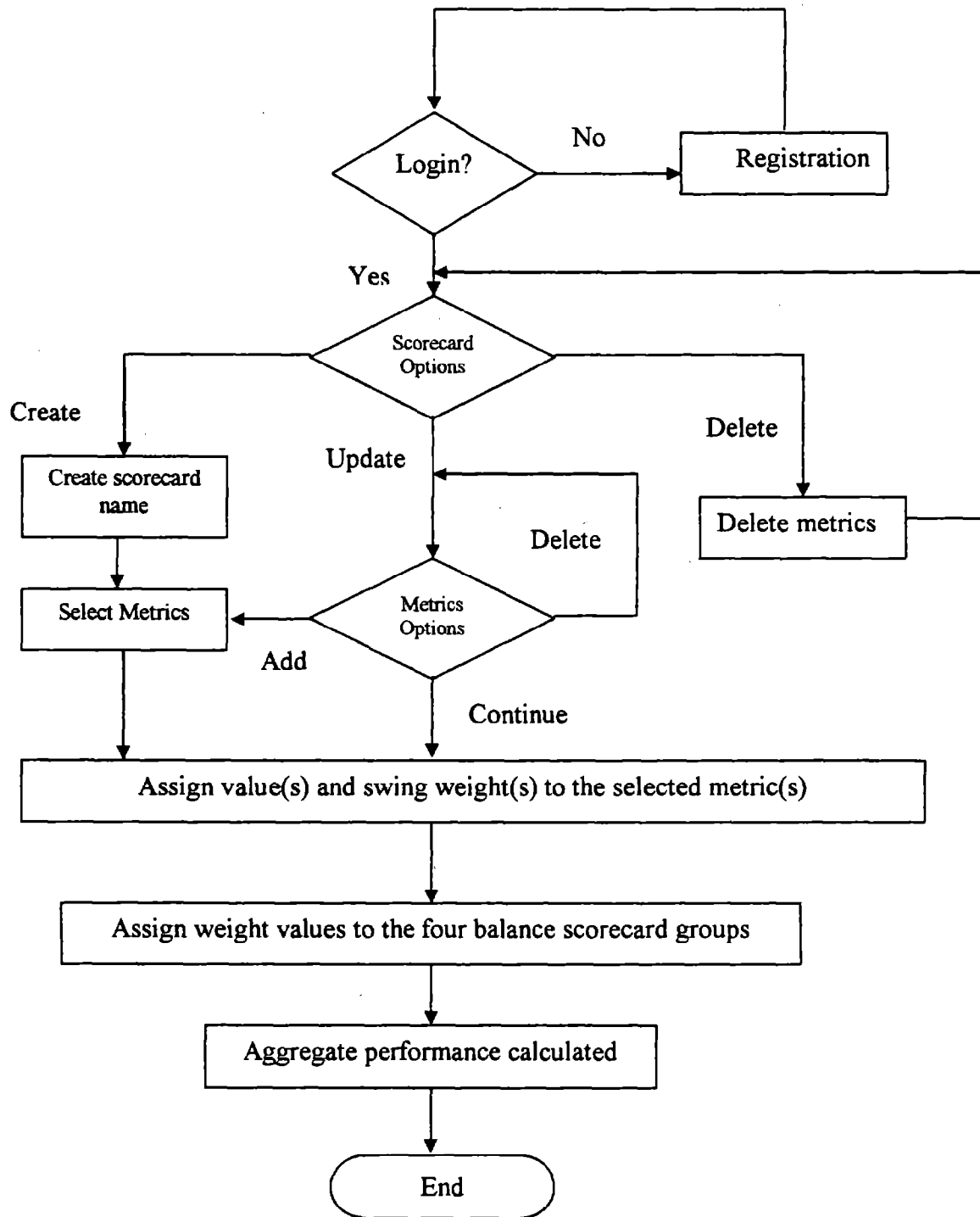


Figure 10. Structure of SMART based performance analysis application

If the user has decided to continue the performance analysis, he/she must either create a new scorecard, continue to work on an existing scorecard, or delete an existing scorecard.

Case One: Create New Scorecard

Assume that the user wishes to create a new scorecard by selecting the “create a scorecard” option and presses the submit button. Then, the user will be brought to a scorecard creation page. In the scorecard creation page, the user is required to complete a simple form. Specifically, the user has to create a name for the current scorecard. Upon completion of the form, the user submits the form. The form submission does three things: (1) Stores the name of the scorecard and the creation date, (2) Assign a scorecard id for the user, and (3) redirect the page to “SM_S2.asp”. At this point, the importance of “scorecard id” exceeds the “user id” because we use scorecard id to identify each individual instead of user id. Since only users who decided to use SMART based application will be assigned a scorecard id, it is more convenient to use scorecard id as identification instead of user id. In the ASP code, the value of scorecard id is stored in the session variable “session(“scid”)”.

After a name had been assigned to the scorecard, the user must decide the metrics that he/she wishes to include in the scorecard by selecting at least one metric from the metric list page. Then, the user submits the form and the selected metrics will be stored in the user’s scorecard and the user will be brought to “metrics value/weight” page. The “metrics value/weight” page is a user interface that let the user assigns swing weights and metric values to the selected metrics. Note that if the user has participated in the benchmarking survey before, the metrics value text field will be automatically filled in.

Then, the user can submit the form. The form submission does two things: (1) Stores both metric weights and values, and (2) redirect the page to “SM_S3.asp”.

In the next step, the user has to assign weight value to the categories, which are Internal Business Process, Learning and Growth, Financial, and Customer. Similarly, the user submits the form by clicking the submit button. The form submission does three things: (1) Stores the value of category weights, (2) store the weight, and (3) redirects the page to “SM_S4.asp”.

The “SM_S4.asp” page display results of analysis, which is in the form of aggregate performance. In this page, all the users who have the same metrics in their respective scorecards will have their aggregate performance calculated. (See “3.3.3 Performance Analysis Based on SMART” for more information).

In fact, “SM_S4.asp” is heavily programmed and a lot of calculations are performed so that aggregate performance can be found. Basically, the program on this page is divided into three parts:

The First Part:

The first part of the program checks if there is any user in the database who has the same metrics that has been selected by the current. Each metric in the metric profile of the current user is checked against other user’s metrics profile. Every time a matched profile is found, the aggregate performance of the matched profiled will be calculated in “The Second Part”.

The Second Part:

In this part, the program calculates the aggregate performance by following the steps below:

- (i) Normalize the metric weight and store the normalized weight.
- (ii) Mapped/normalize the value of each metric by using linear value function.
The linear relationship is found by taking the maximum value of metrics value and minimum value of metrics from the database. Then, a linear equation is found by using these maximize and minimize value.

Then, the system calculates the user's aggregate performance based on the data supplied by step (i) and (ii).

The Third Part:

In this part, the code displays the results of aggregate performance for the current user and other users (who have the matching performance metrics). "A picture is worth a thousand words." Therefore, we want to be able to display the results graphically, so we created a bar chart.

The third part concludes the program as well as the SMART based application. Note that in order to manipulate data between and in the web pages, one has to create appropriate SQL statements and recordsets so that only specific data will be extract from the database.

Case Two: Edit an Existing Scorecard

On the other hand, if the user has decided to work on an existing scorecard, then, the user will be given the option to change part or all of the previous assigned weight and metric values. Then, aggregate performance will be calculated (based on the new values) as in Case One.

Case Three: Delete an Existing Scorecard

If the user has decided to delete an existing scorecard, then he/she must select the scorecard that is displayed in the page by selecting in the associate scorecard ID in a list menu. After the user has selected the scorecard and pressed the submit button, the user will be direct to a confirmation page that is used to confirm the delete action. After the confirmation, the scorecard will either be deleted or the action will be cancelled, depends on the user's choice. After the delete action, the user will be redirect to the SMART homepage.

In the following, we direct our attention to the technology that we used to create our website, which is known as the Active Server Page (ASP).

4.5 ASP Databases

In this section, we wish to discuss the common ActiveX Data objects (ADO) that we used to create the website. In addition, we will discuss some Active Server Pages basics and its objects as well. We begin the discussion by introducing the ASP.

4.5.1 ASP

ASP allows the web programmer to connect database to the Internet so that information from the current state of database can be accessed in real time. Whenever the information in the database is changed, the associated web site will instantly reflect the changes without the need to change the HTML code.

There are six Active Server Objects, as shown in the following:

- (1) Request
- (2) Response
- (3) Server
- (4) Application
- (5) Session
- (6) Object Context

The following object descriptions are excerpt from “Beginning ASP Databases” by Kauffman et al (1999).

Request object: This is one of the most frequently used object in the website. The object used to deal with a request that a user might make of a site or application.

Response object: A frequently used object. This object is used to deal with the server’s response back to the browser.

Server object: The object provides several commonly used functions, such as setting timeout properties for scripts and converting text into HTML or URLs, by far the most important is its ability to create new objects or components. Again, another frequently used object.

Application and session object: These objects are used to manage information about the application that is currently running and the unique instances (versions) of the application, which individual users run, known as sessions. Note that session object is frequently used in the website.

Object Context: The object is used with Microsoft Transaction Server. This object was not used in the website.

4.5.2 ADO

ADO is the latest database interface technology developed by Microsoft that allows universal data access. In other words, ADO allows us access to information held in a database of one type from a database package to another type. As a result, we can access the data that held in “Oracle” from “Access” and vice versa. The lowest layer of this interface is known as ODBC, or Open Database Connectivity. However, the complicated structure of ODBC and limited data type access prevent many programmers from effectively using the full potential of the powerful interface. Recognizing the problem, Microsoft creates another database interface that sit on top of ODBC, which is known as OLE-DB. According to Microsoft, the new interface is more efficient and user-friendlier.

In fact, OLE-DB allows program to access information in any type of data store, including spreadsheets, graphs and email. In addition, a database driver that known as OLE-DB provider allows us to use the ODBC driver for specific database.

Even though OLE-DB is user-friendlier than ODBC, it is still hard to learn and only a limited programming language can be used to manipulate it. Therefore, a higher level of database interfaces known as ADO is available. In fact, ADO is language independent that we can use many programming languages to manipulate it. In our website, we used Vbscript as our language of choice. Vbscript is used because of its simplicity, popularity, and myriad support sources on the Internet. Figure 10 showed the relationships of the old and new database interface.

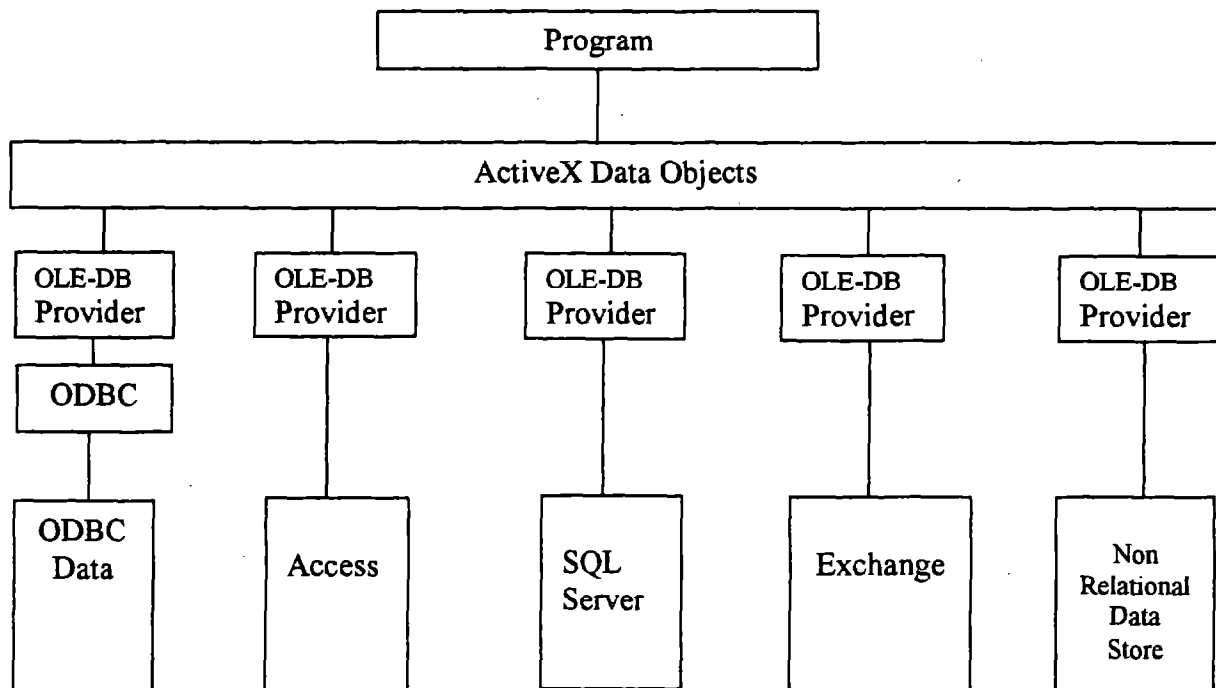


Figure 11. Relationship between different levels of database interface
(Diagram adopt from "Beginning ASP Databases" by Kauffman et al. pp.17)

In the following, we discuss in general the ADO objects that I often used in the website.

4.5.3 The ADO object Model

There are three main objects on which the ADO object model is built:

- The Connection Object
- The Command Object
- The Recordset Object

(1) The Connection Object – We use this object to make a connection to the database.

Once a connection is established, we can use it as many time as we wish.

(2) The Command Object – We use command object to run command against the database. However, the “command” is in SQL instead of ASP script. The command object is usually used to return information from a database, add new record, new tables or delete information within the database.

(3) The Recordset Object – This object is the most frequently used object in our code.

The recordset object can be used to amend and view the information within the database. There are many methods and properties that are associated with the recordset. Specifically, we can use recordset to find record, delete record, move through the record, restrict view of record, update record, and sort record.

As one may find in the code, we exclusively use the connection object and the recordset object to extract the records that we want to manipulate.

4.6 System Evaluation

After the web site has been built, we conducted a system evaluation survey. In this survey, a total of five people have participated in the evaluation process. The five person were selected for their knowledge in such system. In other words, the participants must familiar with at least one of the following items:

- (1) Web design,
- (2) Know at least one programming language,
- (3) Some knowledge about SMART application,

We assigned five tasks to the participant and each task must be performed by using the system. In the following, we described the tasks performed:

Task One: Browse the website freely for 5 minutes.

Task Two: Perform a user registration.

Task Three: Login to the system

Task Four: Take all five questionnaires

Task Five: Use SMART based online application

The evaluation process took less than one hour to complete. We asked the participant to record any problems encountered during the five tasks. In addition, the participants were required to record the web page that produced the error and the type of error. After the errors had been reported, we discussed the problems with the participant. The discussion was to verify the problem. In the following, we listed some of the verified problems found after the evaluation:

Type of Error: Broken links

Description: "Home" broken link in the banner.

Location: survey.asp

Type of Error: registration problems

Description: Error message appear when trying to register

Location: registration.asp

Type of Error: Wrong links

Description: "Home" links to another site called "PMRG" in the banner.

Location: faq.asp

After the problems were verified, they were corrected in the final version of the application.

CHAPTER 5. CONCLUSION

The Online Benchmarking System is intended to facilitate the benchmarking process. In this project, the following tasks were completed:

- A data driven website that is used to facilitate the benchmarking process is created. The website contain tool and resources that may benefit transportation providers.
- A comprehensive list of performance metrics are available online. All metrics are defined with formula and discussion given if available. In addition, the metrics are grouped according to the balance scorecard.
- The online performance analysis application based on SMART provides transportation service providers the ability to benchmark against others and get a rough idea on the companies' performance. The application is written by using ASP and supported by a relational database model. The performance of a company is indicated by an index known as the "aggregate performance".
- Five questionnaires were available online so that performance data can be collected. Since SMART based application uses the performance data that is supplied by either the user or online questionnaires, the questionnaires are extremely important to ensure the success of the SMART based application. In addition, all performance data collected online will be stored in the database.

However, the completion of the project does not necessary signify the end of the project. In fact, there is always room for improvements. In the following, we suggest some additional research.

Future Research:

- (1) **Metric relationship improvement:** The relationship that we used to map performance metrics from zero to one hundred is always linear. Even though the mapping is sufficient in many cases, some metrics may have a non-linear relationship in terms of utility to the user. Future research can be done to (i) identify metrics with non-linear utility mappings, and (ii) to develop the appropriate value functions for metric mapping. The result will be a much more accurate mapped value for each metric.
- (2) **Website improvement:** (i) Current website has only one online performance analysis tool (SMART). Future research can be done to integrate additional ranking and rating tools, for instance, ranking and rating based on Analytical Hierarchy Process into the website, (ii) Provide more useful and representative displays for comparing performance such as a graphical dashboard, (iii) More web functionalities can be added, for example, “chat room” is a very good web application that enables the user to chat in real time.

Appendix A: Performance Metrics List

I. Internal Business Measures:

Name: Loading Time per stop
Definition: Time needed to load goods onto a truck
Formula: $\text{Loading Time} / \text{Number of Trips}$
Units: Hour/stop
Purpose: To find out the time needed to load goods into a truck every time a truck stops for loading and unloading purposes.
Discussion: This metric may help to identify potential bottlenecks in delivery or shipping operations.

Name: Unloading Time per stop
Definition: Time needed to unload goods from a truck
Formula: $\text{Unloading Time} / \text{Number of Trips}$
Units: Hour
Purpose: To find out the time needed to unload goods into a truck every time a truck stops for loading and unloading purposes.
Discussion: This metric may help to identify potential bottlenecks in delivery or shipping operations.

Name: Loading Capacity
Definition: Maximum load per truck in ton
Formula: N/A
Units: Tons
Purpose: Used to identify the loading capacity of trailers.
Discussion: This metrics is needed to derive other metrics, such as "Average load of truck".

Name: Average Load in Truck
Definition: Average load per truck in tons per trip
Formula: $\text{Load} / \text{Number of trucks}$
Units: Tons/Truck
Purpose: Used to track the average load of goods in a truck
Discussion: From a transportation service provider's perspective, it is desirable to load as many goods as possible in a truck; however, government weight limit regulation must not be exceeded.

Name: Length of haul
Definition: Average distance traveled in miles per trip
Formula: $\text{Length of haul} / \text{number of trips}$
Units: Miles/trip
Purpose: To track the average length of haul of trucking operation.
Discussion: From a transportation service provider's perspective, it is desirable to operate in a distance that is not too far away from the headquarter/maintenance office. Shorter distance may save on truck maintenance cost and reduce empty miles.

Name: Average Speed
Definition: Average speed of truck during operation
Formula: N/A
Units: Mph
Purpose: This metrics is used to track the average speed of truck.
Discussion: From a transportation service provider's perspective, it is desirable to operate truck in high driving speed to meet customer goal. However, the trade off is government regulation and highway safety.

Name: Operating hour / Truck
Definition: Average hours in truck operation
Formula: Total operating hour / # of truck/week
Units: hour/truck/week
Purpose: This metric is used to track the average operating hour of truck in a week.
Discussion: Equipment utilization is one of the keys to better productivity. Equipments or trucks can be operated 24 hours a day if possible to boast productivity. The trade off is higher equipment maintenance cost.

Name: % distance driven empty
Definition: Percentage of miles that the truck is driven completely empty
Formula: $(\text{distance empty load} / \text{total distance}) * 100\%$
Units: %
Purpose: This metric is used to track the empty mileage of a truck.
Discussion: Empty mile has an adverse effect on the productivity of a company. This metric can be used to modify the schedule or network structure of the trucking operation so that empty mile can be reduced to the minimum.

Name: Time driven between 2 stops
Definition: Driving time between 2 stops
Formula: N/A
Units: Hour
Purpose: This metric is used to measure the average driving time travel between two stops.
Discussion: This metrics can be used to measure the transportation network density.

Name: Stop time
Definition: Average time that a truck spends in a stop
Formula: N/A
Units: Hour
Purpose: This metric can be used to track the idle time in the stop.
Discussion: Idle time should be reduced to the minimum. Even though a truck has to stop somewhere to refuel or take a break, the idle time should be keep to the minimum.

Name: Load factor
Definition: A ratio of average load over load capacity
Formula: $\text{Average load} / \text{Load capacity}$
Units: N/A
Purpose: This metric is used to measure the utilization of truck's load capacity.
Discussion: The ideal situation is 100% load factor. This is another key metric for equipment utilization.

Name: # of stop per route
Definition: Average number of stops made in a route
Formula: $\text{Total number of stops} / \text{total number of routes}$
Units: Stops / Trip
Purpose: This metric is used to measure the number of stop that a driver has to make in order to complete the route.
Discussion: This metric can be used to measure the transportation network density. The more stops in a route, the higher the density. According to a study, company usually performs better with higher network density.

Name: % driven not empty
Definition: Percentage of miles that the truck is driven full or partially full
Formula: $(\text{Distance driven full or partially full load} / \text{Total driving distance}) * 100\%$
Units: %
Purpose: This metric is used to track the non-empty mileage of a truck.
Discussion: The non-empty mileage should be keep as high as possible. A high value of "% driven not empty" indicates well-planned route and efficient trucking schedule.

Name: Number of trucks active in company
Definition: Average number of trucks that is driven everyday
Formula: N/A
Units: Trucks
Purpose: This metric is used to track the number of trucks that is driven everyday.
Discussion: This is another metric that is used to measure the equipment utilization. Equipments can be operated 24 hours a day if possible to boast productivity. The trade off is higher equipment maintenance cost.

Name: Tracking Accuracy
Definition: Accuracy of shipment tracking
Formula: $(\text{The \# of trucks with a known location} / \text{Total \# of trucks}) * 100\%$
Units: %
Purpose: This metric is used to track the accuracy of shipment tracking.
Discussion: Effective shipment tracking keep mishandling to the minimum.

Name: Inventory record accuracy
Definition: Accuracy of availability of inventory
Formula: $(\# \text{ of correct records} / \text{Total \# of records}) * 100\%$
Units: %
Purpose: This metric is used to measure the availability of inventory in a warehouse.
Discussion: Strictly for warehouse uses only. Some transportation company has warehouses. Accurate inventory record ensures efficient operation of the warehouse.

Name: Forecast accuracy
Definition: Accuracy of forecast on customer demand
Formula: N/A
Units: %
Purpose: This metric is used to track the forecast accuracy of customer demand
Discussion: The importance of customer demand cannot be understated. An accurate forecast ensures the customer demand will be met.

Name: Cycle time
Definition: Time needed to complete a route
Formula: N/A
Units: Hours
Purpose: This metric is used to measure the time needed to complete a route.
Discussion: A short cycle time is desirable in most cases. A short cycle time ensures goods to be delivered in time and increase the availability of fleet.

Name: Pick rate
Definition: The rate of a person to pick up lines of items
Formula: $(\# \text{ of lines picked per person per hour} / \text{lines for all orders}) * 100\%$
Units: %
Purpose: This metric can be used to measure the efficiency of picking up lines of items
Discussion: This metric has an impact on the “loading time” and “unloading time”. Therefore, it is very important to increase the pick rate to ensure efficient operation.

Name: Fill rate
Definition: Percentage of orders filled
Formula: $(\# \text{ of filled orders} / \text{Total \# of orders}) * 100\%$
Units: %
Purpose: This metric is used to track the average rate to complete an order.
Discussion: A high fill rate is highly desirable. A high fill rate may indicate efficient trucking operation and high customer satisfaction.

Name: Maintenance efficiency
Definition: Efficiency of warehouse maintenance
Formula: $\text{maintenance cost} / \text{activity}$
Units: \$/activity
Purpose: This metric is used to measure the maintenance efficiency of a warehouse in terms of cost per maintenance activity.
Discussion: It is highly desirable to keep the cost down. In this case, maintenance cost is one the costs that worth looking into.

Name: Material handling rate
Definition: It is defined as material handling expense over material handling asset value
Formula: $(\text{material handling expense} / \text{material handling asset value}) * 100\%$
Units: %
Purpose: This metric is used to measure the rate of material handling.
Discussion:

II. Customer

Name: Data entry accuracy
Definition: Accuracy of customer order entry process
Formula: $(\# \text{ of errors} / \text{Total} \# \text{ of orders}) * 100\%$
Units: %
Purpose: This metric is used to measure the accuracy of customer order entry
Discussion: It is highly desirable to keep the accuracy up. A wrong order will affect customer satisfaction greatly.

Name: Complaint rates
Definition: Average number of complaints received
Formula: $(\text{Total} \# \text{ of complaints} / \text{Total} \# \text{ number of customers}) * 100\%$
Units: %
Purpose: This metric is to measure the complaint rate received from customers.
Discussion: This is an important metric to measure customer satisfaction. The metric is widely used in the industry.

Name: % correct order
Definition: The percentage of order that is taken correctly
Formula: $(\# \text{ of correct order} / \# \text{ total of order}) * 100\%$
Units: %
Purpose: This metric measures the percentage of customer order that is taken correctly.
Discussion: This metric can be the complement of the metric "data entry accuracy".

Name: % order returned
Definition: Percentage of orders being returned by customers
Formula: $(\# \text{ of return} / \text{Total \# of order}) * 100\%$
Units: %
Purpose: This metric measures the percentage of orders being returned by customers
Discussion: This is another important metric that is used in the industry to measure customer satisfaction.

Name: Delivery date compliance
Definition: Goods being delivered to the customer before the due date
Formula: $(\# \text{ of on time deliveries} / \text{total \# of deliveries}) * 100\%$
Units: %
Purpose: This metric measures the goods being delivered to the customer before the due date
Discussion: This is a crucial metric that is widely used in the transportation service industry. Study showed that delivery date compliance has a great impact on the customer satisfaction.

Name: Re-purchase rate
Definition: Customer repeats business with company
Formula: $(\# \text{ of repeat business} / \text{Total \# of business}) * 100\%$
Units: %
Purpose: This metric measures the rate of customer repeats business with company.
Discussion: A high re-purchase rate indicates highly satisfied customers.

Name: % orders on time
Definition: The percentage of orders loaded on the truck without delay
Formula: $(\% \text{ of on time order} / \text{Total order}) * 100\%$
Units: %
Purpose: This metric measure the percentage order that is loaded on the truck without delay.
Discussion: This metric has an impact on the “delivery date compliance”. A high percentage of “% orders on time” may ensure a high “delivery date compliance” rate.

Name: Service Termination rate
Definition: Customer terminates service with a company
Formula: $(\# \text{ of termination} / \text{total \# of business}) * 100\%$
Units: %
Purpose: This metric measures the rate of customer terminates service with a company.
Discussion: This metric is the opposite of the metric “re-purchase rate”.

Name: Claims Rate
Definition: Customer request money back or re-send product because of defective product
Formula: $(\# \text{ of claims} / \text{total \# of shipment}) * 100\%$
Units: %
Purpose: This metric measures rate of customer claims on a particular order due to defective product caused by mishandling.
Discussion: A high claims rate usually indicates problems in goods handling.

Name: Complete order rate
Definition: Order complete with no process problem and handling error
Formula: $(\# \text{ of complete order} / \text{total \# of shipment}) * 100\%$
Units: %
Purpose: This metric measures the order that is completed with no process problem and handling error
Discussion: One may consider this metric as the opposite of the metric "claims rate".

Name: Damage free rate
Definition: Product delivered without defect
Formula: $(\# \text{ of damage free products} / \text{total \# of delivered products}) * 100\%$
Units: %
Purpose: This metric is used to measure the rate of product delivered without defect.
Discussion: This metric is highly related to "claims rate". In fact, this metric may be the substituted for "claims rate".

Name: On-time delivery
Definition: Product delivered to customer without delay
Formula: $(\# \text{ of on-time delivery} / \text{total orders}) * 100\%$
Units: %
Purpose: This metric measures the rate of product delivered to customer without delay.
Discussion: This metric is highly related to "delivery date compliance". In fact, this metric may be substituted for "delivery date compliance".

Name: On-time order entry
Definition: Order is taken care of without delay
Formula: $(\# \text{ of on-time entries} / \text{total orders}) * 100\%$
Units: %
Purpose: This metric is used to measure the percentage of order processed without delay.
Discussion: After an order had been taken, the time needed before the order was processed is known as delay. There are many reasons if an order is delayed, including inaccurate data entry, inaccurate customer order or customer request changes on the order.

Name: Correct destination rate
Definition: Accuracy of products being delivered to correct destination
Formula: $(\# \text{ of correct delivery} / \text{total} \# \text{ of delivery}) * 100\%$
Units: %
Purpose: This metric measure the accuracy of products being delivered to correct destination.
Discussion: If goods were not delivered to the correct destination as intended. Customer confidence in the company will be greatly reduced. Note that even low level of incorrect destination will affect the company's image.

Name: Defect rate
Definition: Defects in goods caused by delivery
Formula: $(\# \text{ of defect products} / \text{Total} \# \text{ of products}) * 100\%$
Units: %
Purpose: This metric measures the defect rate of goods caused by delivery.
Discussion: This metric is the opposite of the metric "damage free rate". One may adopt either the "defect rate" or "damage free rate" only.

III. Financial

Name: Direct cost per truck
Definition: Direct cost of truck includes truck depreciation, insurance, leasing. Costs that are directly caused by truck operation.
Formula: $(\text{Total direct costs} / \# \text{ of trucks}) * 100\%$
Units: %
Purpose: This metric is to measure the average direct cost per truck.
Discussion: Since the profit margin of transportation service is "thin", the reduction of direct cost per truck has an positive impact on the bottom line.

Name: Wages per driver
Definition: Average wage rate of driver
Formula: N/A
Units: \$/miles
Purpose: This metric measures the average wage of driver.
Discussion: Performance of truck driver is directly proportionate to wage rate. Note that wages of driver is one of the major financial expenses.

Name: Variable cost/distance/truck
Definition: Costs that vary with the utilization rate of trucks
Formula: Total variable cost/average distance traveled per truck. For example, vehicle parts, vehicle maintenance, oils, lubricants and coolants.
Units: \$/miles/truck
Purpose: This metric measures the costs that vary with the utilization rate of trucks.
Discussion: Variable costs are generally harder to measures. In this metric, variable costs are associated with distance and truck. Again, if the variable costs can be lowered, it has a positive impact on the bottom line.

Name: Revenue/Wages
Definition: Total revenue of the company over total wages expense
Formula: $\text{Total Revenue} / \text{Total wages expense}$
Units: No unit
Purpose: This metric calculates the ratio of revenue to wages expenses.
Discussion: This metric looks into the relationship between wages and revenue. In fact, one may be interested to know how much revenue can be generated per unit input of wages. Then, this is the metric that can answer the question.

Name: Revenue/direct cost
Definition: Total revenue of the company over total direct cost of trucking operation
Formula: $\text{Total revenue} / \text{Total direct cost}$
Units: No unit
Purpose: This metric calculates the ratio of revenue to direct cost of trucking operation.
Discussion: This metric looks into the relationship between revenue and direct cost. In fact, one may be interested to know how much revenue can be generated per unit expenses of direct cost. Then, this is the metric that can answer the question.

Name: Revenue/Driver
Definition: Average revenue that can be generated by one truck driver
Formula: $\text{Total Revenue} / \text{Total \# of driver}$
Units: \$/driver
Purpose: This metric calculates the ratio of revenue to driver of trucking operation.
Discussion: This metric looks into the relationship between revenue and driver. In fact, one may be interested to know how much revenue can be generated per driver. Then, this is the metric that can answer the question.

Name: Revenue/(loading + unloading time)
Definition: Average revenue over the loading and unloading time
Formula: $\text{Total revenue} / (\text{total loading} + \text{total unloading time})$
Units: \$/hour
Purpose: This metric calculates the ratio of revenue to loading and unloading time.
Discussion: This metric explores the relationship between revenue and loading/unloading time.

Name: Revenue/driving time
Definition: Average revenue per driving time
Formula: $\text{Total revenue} / \text{total driving time}$
Units: \$/hour
Purpose: This metric calculates the ratio of revenue to driving time.
Discussion: This metric looks into the relationship between revenue and driving time. In fact, one may be interested to know how much revenue can be generated per unit input of driving time. Then, this is the metric that can answer the question.

Name: Revenue/Trip
Definition: Average revenue generated per trip
Formula: $\text{Total Revenue} / \text{Total \# of trips}$
Units: \$/trip
Purpose: This metric calculates the ratio of revenue to trip completed.
Discussion: This metric looks into the relationship between revenue and driving time. In fact, one may be interested to know how much revenue can be generated per unit input of completed trip. Then, this is the metric that can answer the question.

Name: Revenue/truck
Definition: Average revenue generated per truck
Formula: $\text{Total revenue} / \text{Total \# of truck}$
Units: \$/truck
Purpose: This metric calculates the ratio of revenue to truck.
Discussion: This metric looks into the relationship between revenue and truck. In fact, one may be interested to know how much revenue can be generated per truck. Then, this is the metric that can answer the question.

Name: Revenue/variable costs
Definition: Total revenue over total variables cost
Formula: $\text{Total revenue} / \text{total variables cost}$
Units: No unit
Purpose: This metric calculates the ratio of revenue to variable costs.
Discussion: This metric looks into the relationship between revenue and variable costs. In fact, one may be interested to know how much revenue can be generated per unit expense of variable costs. Then, this is the metric that can answer the question.

Name: Revenue/Distance
Definition: Total revenue over distance traveled by trucks
Formula: Total revenue/Total distance traveled by trucks
Units: \$/mile
Purpose: This metric calculates the ratio of revenue to distance traveled.
Discussion: This metric looks into the relationship between revenue and distance. In fact, one may be interested to know how much revenue can be generated per unit distance. Then, this is the metric that can answer the question.

Name: Revenue/driver work hour
Definition: Total revenue generated per driver work hour
Formula: Total revenue/work hour
Units: \$/hour
Purpose: This metric calculates the ratio of revenue to distance traveled
Discussion: This metric looks into the relationship between revenue and driver work hour. In fact, one may be interested to know how much revenue can be generated per unit work hour. Then, this is the metric that can answer the question.

Name: Shipping and handling cost
Definition: The cost associated with shipping and handling
Formula: N/A
Units: \$
Purpose: This metric measures the cost associated with shipping and handling.
Discussion: The shipping and handling cost should be kept tracked from time to time. A sudden increase in this cost signifies potential problem or changes in the operation.

Name: Transaction Cost
Definition: The cost associated with customer order transactions
Formula: Total transaction cost per week/# of transaction per week
Units: \$/transaction
Purpose: This metric measures the cost associated with customer order transactions.
Discussion: This is a cost that associated with customer order handling.

Name: Logistics operating expenses
Definition: Expenses associated with truck logistics operation
Formula: N/A
Units: \$
Purpose: This metric measures all the expenses that associated with truck logistics operation.
Discussion: All logistic direct cost and variable cost should be taken into account.

Name: % return on asset
Definition: Percentage return of profit to the current asset
Formula: $(\text{Profit}/\text{Asset}) * 100\%$
Units: %
Purpose: This metric measures the percentage return of profit to the current asset.
Discussion: This is metric that measures the return to asset.

Name: % return on investment
Definition: Percentage return of profit to the initial investment
Formula: $(\text{Profit}/\text{Initial investment}) * 100\%$
Units: %
Purpose: This metric measures the percentage return of profit to the investment.
Discussion: This is a metric that suits the purpose of measuring the percentage return of profit to the initial investment.

Name: Revenue growth rate
Definition: The percentage growth of revenue per year
Formula: $[(\text{Current year revenue} - \text{Last year revenue}) / \text{Current year revenue}] * 100\%$
Units: %
Purpose: This metric measures the percentage growth of revenue per year.
Discussion: It is important to know the current financial status of the company. This metric measure how much a company has grown in the previous year.

Name: Market share
Definition: The proportion of total sales of freight service by a trucking company in transportation service market.
Formula: $(\text{Total Annual Revenue} / \text{Total market value}) * 100\%$
Units: %
Purpose: This metric measures the proportion of total sales of freight service by a trucking company in transportation service market.
Discussion: This is a metric that implies the competitiveness of a company. A shrinking market may signify the need to change operation strategy.

Name: Net profit margin
Definition: The amount by which income exceeds the related expenditures
Formula: no formula
Units: \$
Purpose: This metric measures the amount by which income exceeds the related expenditures.
Discussion: Since the profit margin in freight service is very slim, one should always keep the profit margin in check.

IV. Learning and Growth

Name: Absent rate
Definition: The proportion of absent days to the total work day in a month
Formula: $(\# \text{ of absent days per month} / \text{Total \# of workdays in a month}) * 100\%$
Units: %
Purpose: This metric measures the absent rate of driver.
Discussion: Absent rate can hurt the profitability and productivity of a company. Keeping the absent rate to the lowest level is a challenge to many trucking company.

Name: Training received
Definition: The average # of hours of training provided to truck operators
Formula: $(\# \text{ of training hours} / \# \text{ of employee}) * 100\%$
Units: hours/person/year
Purpose: This metric measures the average of hour that a driver or employee received.
Discussion: Appropriate training is vital to the quality and performance of employee. However, from the company's perspective, training cost may be an inevitable trade off.

Name: Number of recognition
Definition: The average Recognition or incentive awards to outstanding employee per year.
Formula: N/A
Units: recognition/year
Purpose: This metric measures the average number of incentive awarded to outstanding employee.
Discussion: Recognition is highly and positively related to employee's job satisfaction and performance.

Name: Accident rate
Definition: Average number of accidents over total number of work days per month
Formula: $(\# \text{ of accidents per month} / \text{total \# of work days}) * 100\%$
Units: %
Purpose: This metric measures the average rate of accident
Discussion: Safety is the important issue in the transportation service industry.

Name: Availability rate
Definition: The availability of employee when requested to perform a task.
Formula: $(\# \text{ of availabilities} / \# \text{ of requests}) * 100\%$
Units: %
Purpose: This metric measures the availability of employee when requested to perform a task
Discussion: This metric is the opposite of the metric "absent rate".

Name: Education
Definition: The level of education of truck operators
Formula: N/A
Units: N/A
Purpose: This metric keeps track of the education of driver.
Discussion:

Name: Turnover rate
Definition: The proportion of employee quit over average number employed
Formula: $(\text{Total \# of leavers per year} / \text{Total average \# employed per year}) * 100\%$
Units: %/year
Purpose: Used to identify the turnover rate of driver. The lower the turnover rate, the better it is to the company in terms of training cost.
Discussion: Driver turnover is a serious issue in the trucking industry. Many incentive programs have been created to increase the retention rate of driver. High turnover rate also implies high driver training cost. Quality of driver may also suffer.

Name: Grievance
Definition: Complaints, disputes about company practices
Formula: N/A
Units: grievances/month
Purpose: This metric measures the number of complaints, disputes about company practices.
Discussion: This metric can be used to modify a particular practices if grievances are often received concerning the practice.

Name: Recruitment Rate
Definition: The number of employment opportunities accepted per month
Formula: $(\text{\# of accepted offers} / \text{total \# of offers}) * 100\%$
Units: %
Purpose: This metric measures the number of employment opportunities accepted per month
Discussion: Increasing recruitment rate implies the growth of company.

Name: Promotion rate
Definition: The number of promotions offered per year
Formula: $(\text{\# of promotion} / \text{\# of employee}) * 100\%$
Units: %
Purpose: This metric measures the average number of promotions offered per year.
Discussion:

Name: Average # of night a driver's home/week
Definition: The number of night in a week that a typical driver may spend in his home
Formula: N/A
Units: night/week
Purpose: A useful metrics that can be used to track the satisfaction of employee
Discussion: Drivers are normally happier if they get to stay home more often with their family. This metrics can be used to make sure the drivers get to stay home several days a week.

Name: % offers accepted
Definition: The number of employment offer accepted per year
Formula: N/A
Units: %
Purpose: Used to track the number of offers accepted every year.
Discussion: A low rate of accepted offers may indicate potential problem in the company's employment policy.

Name: Driver working hour
Definition: Average driver-working hour per week
Formula: Total work hours per week / # of driver/week
Units: Hour/driver/week
Purpose: This metric measures the average driver-working hour per week
Discussion: This metric can be used to create schedule worker. A company must ensure work hour limit per driver per week is not exceeded, as required and outlined by the department of transportation.

Appendix B: Questionnaire

Categorization of Carriers

The purpose of this section is to classify the transportation carrier operations by their primary type of industry segment served. This will facilitate the comparison of metrics across industry segments.

- 1) Which type of carrier best characterizes your company
 - a) A for-hire carrier (A for-hire carrier engages in transportation, for compensation, of one or more classes of freight that is the property of others)
 - b) A private carrier (A private carrier is a firm that transports their own commodities by their owned or leased vehicles)
- 2) Which of the following term best describes your firm?
 - a) Common carrier (A transportation business that offers service to the general public)
 - b) Contract carrier (Contract carriers are restricted to serving specified shippers in a well-defined contractual arrangement)
- 3) Which of the following best describes the type of routes your company uses?
 - a) Regular route carrier
 - b) Irregular route carrier
- 4) Which of the following best describe the type of service your company provides?
 - a) Scheduled service
 - b) Unscheduled service
 - c) Radial service
 - d) Non radial service
- 5) What type of carriage do you specialize in?
 - a) General freight
 - b) Household freight
 - c) Specialty freight
- 6) If you are specialize in “general freight”, which type of carriage makes up the majority of your revenue?
 - a) Less than truckload
 - b) Truckload

7) Do you specialize in parcel (Includes expedited and courier) freight?

Yes _____ No _____

8) Do you specialize in container freight?

Yes _____ No _____

9) If you are specialize in "specialty freight", which type of carriage makes up the majority of your revenue?

- a) Heavy equipment
- b) Liquid petroleum or chemical products
- c) Bulk chemical
- d) Refrigerated liquid products
- e) Refrigerated solid products
- f) Dump trucking
- g) Agricultural commodities
- h) Motor vehicles
- i) Armored truck service
- j) Building materials
- k) Films and associated commodities
- l) Forest products
- m) Mine ores not including coal
- n) Retail store delivery service
- o) Explosives or dangerous articles
- p) Others (Please specify) _____

10) Which jurisdiction do you primarily serve?

- a) Local operations- Local operations refer to transportation performed within a municipality and its commercial zone.
- b) Intrastate operations-Intrastate operations refer to transportation performed within a state and its commercial zone.
- c) Interstate-Interstate operations refer to transportation performed between states.

11) Which form of business organization best describes your company?

- a) Sole proprietorship
- b) Partnership
- c) Publicly held corporation
- d) Corporation with no publicly held stock

12) What class of motor carrier is your firm?

- a) Class I (Common or contract motor carrier of property that have average gross operating revenues of \$10 millions or more annually from motor carrier operations)
- b) Class II (Common or contract motor carrier of property that have average gross operating revenues of \$3 millions or more, but under \$10 millions annually from motor carrier operations)
- c) Class III (Common or contract motor carrier of property that have average gross operating revenues of less than \$3 millions annually from motor carrier operations)

13) Do you serve as a connecting carrier? (A connecting carrier is a carrier that interchanges trailers with other carriers for completion of shipments.)

- a) Yes
- b) No

Internal Business Process Perspective

Terminal

- 14) How many terminals do you own or operate? (A terminal is a facility including building structures, and equipment for the storage transfer, handling, delivery and reception of vehicles and materials.

_____Terminals

- 15) Among the terminals, approximately how many of them are break-bulk terminals? (In break-bulk terminal, a composite load is separated into individual shipment so that they can be hauled to different intercity destinations)

_____Terminals

- 16) Approximately how many terminals have more outbound freight than inbound freight? That is, there is a net positive flow of goods out of the area that the terminal serves so that empty containers or trailers must be redistributed to the terminal for use for outbound operations.

_____terminals

- 17) Approximately how many terminals have more inbound freight than outbound freight? That is, there is a net positive flow of goods into the area that the terminal serves so that empty containers or trailers must be redistributed from the terminal for use by other terminals.

_____terminals

- 18) Approximately how many empty trailers (containers) must be redistributed within your network per year?

_____terminals

- 19) For a typical terminal, what is the average tonnage processed per year?

_____Outbound freight

_____Inbound freight

- 20) What is the average weight transported for pick up and delivery operations associated with a typical terminal per year? (Pick up and delivery is performed by a motor carrier so that shipments can be picked up from the origin and delivered the destination, as requested by shipper.)

_____tons/year (Truckload)

_____tons/year (Less than truckload)

- 21) On average, how many freight bills are processed in a terminal per year? (A freight bill is a document for a carrier shipment giving a description of the freight, its weight, amount of charges, the rate of charges, taxes, and whether it is collect or prepaid.)

_____ # of outbound freight bills/year
_____ # of inbound freight bills/year

- 22) What is the average amount of material handling equipment hours spent for platform operations (loading/unloading) for a typical terminal per year.

_____ hours/year

- 23) What is the average amount of man-hours spent for platform operations (loading/unloading) for a typical terminal per year?

_____ hours/year

Freight And Movement

- 24) What percentage of freight movements is associated with the following categories?

- a) Carrier both originates and terminates _____ %
b) Carriers originates only _____ %
c) Carrier terminates only _____ %
d) Carrier neither originates nor terminates _____ %

- 25) What is your total mileage operated in intercity service annually?

_____ Loaded miles
_____ Empty miles

- 26) What is your total mileage operated in local service annually?

_____ Loaded miles
_____ Empty miles

- 27) How many tons of revenue freight are carried in intercity service per year?

(Revenue freight – common carrier – This includes all revenues earned by the trucking firm, operating as a common carrier, from the transportation of property in intercity service, including incidental pickup and delivery.)

(Revenue freight – contract carrier – All revenue earned by the trucking firm, operating as a contract carrier, from the transportation of property in intercity service.)

_____ tons/year

28) How many tons of revenue freight are carried in local service per year?

_____ tons/year

29) What is your forecast accuracy of customer demand?

_____ %

Trailer Operations

30) How many tractors does your company have? (Tractor is a cab, an engine-powered vehicle used to pull a trailer.)

_____ Tractors

31) How many trailers does your company have? (Trailer is the part of the vehicle used to haul goods and hooked up to an engine-powered tractor.)

_____ Trailers

32) What type of trailers do you use in your company? (Check all that apply)

Dry van _____

Flatbed _____

Tanker _____

Platform _____

Auto transporter _____

Dry bulk _____

Double _____

Temperature control _____

Bulk _____

Dump _____

Liquid tank _____

Livestock _____

Logger _____

Others _____

33) What is the trailer that is most frequently used in your company?

Dry van _____

Flatbed _____

Tanker _____

Platform _____

Auto transporter _____

Dry bulk _____

Double _____

Temperature control _____

Bulk _____

Dump _____

Liquid tank _____

Livestock _____

Logger _____

Others _____

34) What is the size of the trailer that is most frequently used in your company?

28 foot trailer _____

48 foot trailer _____

Others _____

35) What is the configuration of truck that is most frequently used in your company?

a) Single unit trucks

Conventional Combination Vehicles

b) 5 axle tractor semi-trailer

c) 6 axle tractor semi-trailer

d) STAA/western double

Longer Combination Vehicles

e) Rocky mountain double

f) Turnpike double

g) 8 axle B train double trailer combination

h) Triple trailer combination

36) On average, what is your trailer-loading rate per hour?

(i) Palletized

_____ Trailers/hour/person

(ii) Loose (not palletized)

_____ Trailers/hour/person

37) On average, what is your trailer-unloading rate per hour?

(i) Palletized

_____ Trailers/hour/person

(ii) Loose (not palletized)

_____ Trailers/hour/person

38) Among the trailers and tractors, what percentage of them are actively in operation on a daily basis? (% of tractors, trailers active in operation)

_____ % Tractors

_____ % Trailers

39) What is the average load size of a typical loaded trailer?

_____ lbs (Load size)

40) What is the average load factor of your trucks? (Load factor = Average Load of trailer/Load capacity)

Truck Operations

- 41) What are the average operating hours per truck in a year? (Operating hour/truck)
_____ hours/truck/year
- 42) On average, how many stops do your trucks usually make in a route?
(A "route" is a set of pick up and drop-off points that a driver must visit in order to complete an entire shipment. A "Stop" is pick up and drop-off point in a truck route for loading and unloading only.)
_____ Stops (Including starting and ending points)
- 43) On average, what is the amount of time driven between two stops on a typical route?
_____ hours
- 44) What is the average driving speed of the truck between pick up and drop-off point on a typical route?
_____ mph
- 45) Considering only line haul operations (i.e. movement of freight between cities excluding pick up and delivery service), what is the average length of haul?
(Average distance traveled)
_____ miles (Truckload)
_____ miles (Less Than Truckload)
- 46) If your company is a regular route carrier, what percentage of the time do drivers get to repeat the route?
_____ %
- 47) What is your truck tracking accuracy (Tracking accuracy = the # of trucks with a known location / Total # of trucks)?
_____ %

Warehouse

- 48) Do you own or use at least one warehouse (private/public) in your network?
Yes _____ No _____
If Yes, proceed to question ##
If No, Skip this section

49) What is the typical warehouse's pick rate? (Pick rate = # of lines items picked per person per hour / Total # of lines for all orders)

_____ lines/ person/ hour

50) What is the typical warehouse's fill rate? (Fill rate = # of filled orders / Total # of orders)

_____ %

51) What is the typical inventory record accuracy? (Inventory Record Accuracy = # of correct records / Total # of Records)

_____ %

Customer Perspective

Freight Claims

- 52) How many freight claims does your company handle per year?
_____ claims/year
- 53) Of the total freight claims handled per year, how many are overcharge claims?
(An overcharge claim is a claim cause by erroneous application of rates, weights,
or assessment of freight charges.)
_____ claims/year
- 54) Of the total freight claims handled per year, how many are cargo loss and damage
claims? (A cargo loss and damage claim includes complaints against the motor
carrier for failing to deliver goods to the consignee because of the destruction,
disappearance, or conversion of the freight because of the freight being damaged
by the carrier so as to render its value less to the consignee.)
_____ claims/year
- 55) Of the total cargo loss and damage claims, how many were for known loss or
damage? (A known loss or damage claims covers the case in which the freight is
received by the consignee with loss or damage visible with an exception at the
time of delivery)
_____ claims/year
- 56) Of the total cargo loss and damage claims, how many were for unknown loss or
damage? (An unknown loss or damage claim covers the case in which the freight
is received by the consignee with no loss or damage visible at the time delivery
and is therefore received without exception.)
_____ claims/year
- 57) How long does it take to normally settle freight claims with a customer?
- Minimum _____ days
Most likely _____ days
Maximum _____ days
- 58) What percentage of freight claims are settled within 30 days or less?
_____ %
- 59) What percentage of freight claims are settled within 120 days or less?
_____ %

Shipment Handling

- 60) Among the shipment orders received, what percent of them were immediately processed within 24 hours? (on time order entry)
_____ % orders
- 61) Among the shipment orders received, what percent of them were delivered to the destination correctly? (Correct destination rate)
_____ % Order delivered to correct destination
- 62) Among the shipment orders received, what percentage of them were from prior customers? (re-purchase rate)
_____ % orders
- 63) What percentage of the shipments were delivered to the destination before or on the requested date?
_____ % delivery (Delivery date compliance)

Financial Perspective

Operating Expenses

64) What percentage of operating expenses is due to each of in the following categories? Use estimate as needed. (Operating expenses may be defined as the cost of moving freight and of rendering such other services as pertain to the general business of a trucking firm.)

Line haul _____ %
Pickup and delivery _____ %
Billing and delivery _____ %
Platform _____ %
Terminal _____ %
Maintenance _____ %
Traffic and _____ %
Insurance and safety _____ %
General and administrative _____ %

65) If your firm is a motor carrier of household goods, what percentage of operating expenses are due to each of the following activities?

- a) Interstate moving _____ %
- b) Intrastate moving _____ %
- c) Local moving _____ %
- d) Indirect operating, carrier only _____ %
- e) General and administrative _____ %
- f) Packing and crating _____ %
- g) Warehousing _____ %
- h) Overseas import and export _____ %
- i) Indirect operating, non carrier _____ %

66) What are your annual expenses on fuel, oils, and lubricants? (Include cost of gas, propane, diesel, motor oil, grease, lubricants, and coolants used by revenue vehicles, terminal vehicles, and maintenance vehicles. Exclude taxes for fuel.)
\$ _____/year

67) What is your annual expense on outside maintenance? (Outside maintenance is the maintenance performed by outside vendors. Include total amount paid on invoice – with taxes)
\$ _____/year

68) What are your annual expenses on vehicle parts? (Cost of parts used to repair vehicles. Exclude tires and tubes.)

\$ _____/year

- 69) What is your annual expense on other operating supplies? (Other operating supplies and expenses used in the operations of vehicles, terminals, and shops)

\$ _____/year

- 70) What are your expenses on tires and tubes? (Cost of tires and tubes for vehicles.)

\$ _____/year

Rental Expenses

- 71) What is your expense on rented vehicles with drivers? (This is the amount payable to others for the use of revenue vehicles where vehicle and driver are under control of carrier. Include wages paid to 1099 independent contractors. Exclude wages paid to W-2 drivers.)

\$ _____/year

- 72) What is your expense on rental vehicles without drivers? (This is the amount payable to others for the use of revenue vehicles where vehicle is under control of carrier. Include compensation for use of owner operator vehicles when driver services are paid separately.)

\$ _____/year

Insurance Expenses

- 73) What are your cargo loss and damage premiums and claims paid? (Net cost of commercial insurance to protect the carrier against liability for claims resulting from loss or damage to, or delay of, property being moved or stored by carrier. Include claims paid.)

\$ _____/year

- 74) What are your liability and property damage premiums and claims paid? (Cost of commercial insurance to protect carrier from liability due to deaths or injuries to non-employees and damage to other property caused by carrier's equipment. Include claims paid.)

\$ _____/year

Operating Revenue

- 75) What is your annual freight operating revenue generated from intercity operation? (Revenue from the transportation of property by motor vehicles. Include revenue from common and contract carriage. Include revenue from your portion of interline shipments. Exclude revenue from household goods, compensated intercorporate hauling, and private carriage.)

\$ _____/year

76) What is your annual operating revenue generated by local operation? (Revenue generated from local freight carriage. Exclude revenue from household goods operations.)

\$ _____/year

77) What is your annual household goods carrier operating revenue? (Revenue from intercity common and contract carriage of household goods. Include local household goods revenue. Exclude revenue from noncarrier activities such as packing and warehousing)

\$ _____/year

78) On average, how much revenue can be generated in one trip? (A trip is defined as the route taken to deliver a shipment from start to finish.)

\$ _____/trip

Methods

79) What method of recognizing the occurrence of freight revenue do you use?

- a) Revenue is recognized on the date of pickup or departure from the terminal (without indicating related costs)
- b) Revenue is recognized on the date of pickup (with related costs charged to the period incurred)
- c) Revenue is recognized on the date of pick up (with the accrual of estimated costs)
- d) Revenue is recognized on the date of pick up (with the accrual of estimated costs)
- e) Revenue is recognized on a percentage of completion of the shipment to the consignee
- f) Others _____

Interline Operations

80) What percentage of revenue is derived from interline traffic, i.e. connecting line freight movement involving two or more carriers and/or other modes of transportation?

_____%

81) What method is used to divide interline revenues between the parties? (Interline revenue is the revenue generated by interline traffic)

- a) Prorating mileage- A simple method whereby each carrier receives a percentage of revenue in direct relation to the number of miles it hauls
- b) Prorating rate- This method of division is based on what each carrier's local rate is from or to the interchange point to the total combination rate from the origin to the destination

- c) Prorating combination- This is a simple average of prorating mileage and prorating rate.
- d) Arbitrary division- This is a division of revenue that bears no discernible relation to comparative services, length of haul, or local rates of the respective carriers.

82) What percentage of operating revenue is derived from each of the following categories of service? (Operating revenue may be defined as the earnings that accrue from the movement of freight, mail, express, and other goods whatever designated as well as the earnings from the rendering of such services as ancillary to the general business of the transportation carrier)

- (iii) Intercity common carriage _____ %
- (iv) Intercity contract carriage _____ %
- (v) Local cartage _____ %
- (vi) Intercity transportation for other motor carriers _____ %
- (vii) Other _____ %

Warehouse

83) What is your average annual expense on material handling?
\$ _____ /year (material handling rate)

84) What is your total material handling asset value?
\$ _____

85) What is the annual usage of your inventory (at cost)?
\$ _____ /year

86) What is the average asset value of inventory in your warehouse?
\$ _____

Terminal

87) What is your average annual expense on terminal operations?
\$ _____ /year

88) What is your total material handling asset value of your terminal?
\$ _____

Learning and Growth Perspective

- 89) What is the average number of workdays your company schedules for drivers in a month?
_____ days/month
- 90) How many employees does your company currently have?
_____ employees
- 91) Among your employees, how many of them are truck operators?
_____ drivers
- 92) What is your truck driver absentee rate? (Absentee rate)
_____ %/month
- 93) What is your driver's annual gross pay?
\$ _____ /year
- 94) Do you provide training for your truck drivers?
Yes _____ No _____
If yes, how many training hours are provided to the drivers?
_____ hours/person/year
- 95) On average, how many traffic accident(s) are reported every year?
_____ accidents/year
- 96) What are the average years of trucking experience of your drivers?
_____ years
- 97) What is your employee turnover rate?
_____ %/year
- 98) Do you offer any recognition to your outstanding employees?
Yes _____ No _____
If Yes, what recognition do you offer?

- 99) On average, how many employment opportunities (in general) does your company offer in a year?
_____ Offers/year
- 100) What percentage of offers are accepted?
_____ % Offers

101) How many complaints, disputes about company practices are received per year?
_____ Grievances /year

102) On average, how many hours does a driver work in a week?

_____ hours/week

103) On average, how many days in a week is a driver out of town performing deliveries?

_____ Days/week/driver (Average time between get-home)

104) On average, how many nights in a week does a driver spend at home?

_____ Days/week/driver (average get home)

Appendix C: Sample Survey/Metric Evaluation Package

Note that the following is only a sample excerpt from the survey evaluation package.

Operational Measures

Q1) What trailer size is commonly used in your company (Give at most three different sizes)?

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q2) On average, how much time is needed to load goods into the trailer (that is commonly used)?

_____ hour → Trailer size _____
 _____ hour → Trailer size _____
 _____ hour → Trailer size _____

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q3) On average, how much time is needed to unload goods from the trailer (that is commonly used)?

_____ hour → Trailer size _____
 _____ hour → Trailer size _____
 _____ hour → Trailer size _____

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q4) How many trucks (available within trailer operation) does your company have?

_____ trucks

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q5) Among the trucks, how many of them are actively in operation? (i.e. trucks that are driven every day) (# of trucks active in operation)

_____ trucks

a) Do you understand the key terms of this question? Yes No

If No, please specify _____

b) Is this question is in a wrong or inappropriate category? (Operational) Yes No

If Yes, please recommend a category _____

c) Please rate the relevance of this question to your company's operation:

Least 1 2 3 4 5 most relevant

Please state why:

d) Will data be hard to obtain in order to answer this question? Yes No

If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q6) What is the average load size for the trailer that is commonly used in your company? (Load capacity)

_____ lbs

a) Do you understand the key terms of this question? Yes No

If No, please specify _____

b) Is this question is in a wrong or inappropriate category? (Operational) Yes No

If Yes, please recommend a category _____

c) Please rate the relevance of this question to your company's operation:

Least 1 2 3 4 5 most relevant

Please state why:

d) Will data be hard to obtain in order to answer this question? Yes No

If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q7) On average, how many stops do your trucks usually make in a route?
(A "Stop" is a stopping point in a truck route for loading and unloading only)
 _____ Stops

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q8) How much time does a truck typically spend during a stop?
 _____ hours (Stop Time)

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q9) On average, what is the amount of time driven between two stops?

_____ hours

- a) Do you understand the key terms of this question? Yes No
If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
Least 1 2 3 4 5 most relevant
Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q10) What is the average speed of the truck during operation?

_____ mph

- a) Do you understand the key terms of this question? Yes No
If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
Least 1 2 3 4 5 most relevant
Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q11) What is the average operating hours per truck in a week? (operating hour/truck)

_____ hours/truck

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q12) On average, how many hours does a driver work in a week?
 _____ hours/week

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q13) What percent of the time is a truck is driven empty?
 _____ percent

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q14) On average, what is the average length of a route?
 _____ miles (Average distance traveled)

- a) Do you understand the key terms of this question? Yes No
 If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
 If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
 Least 1 2 3 4 5 most relevant
 Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
 If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q15) How many times does a driver repeat a route in a week?

_____ times

- a) Do you understand the key terms of this question? Yes No
If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
Least 1 2 3 4 5 most relevant
Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q16) What is your truck tracking accuracy (Tracking accuracy = the # of trucks with a known location / Total # of trucks)?

_____ %

- a) Do you understand the key terms of this question? Yes No
If No, please specify _____
- b) Is this question is in a wrong or inappropriate category? (Operational) Yes No
If Yes, please recommend a category _____
- c) Please rate the relevance of this question to your company's operation:
Least 1 2 3 4 5 most relevant
Please state why:

- d) Will data be hard to obtain in order to answer this question? Yes No
If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q17) What is your inventory record accuracy? (Inventory Record Accuracy = # of correct records / Total # of Records)

_____ %

a) Do you understand the key terms of this question? Yes No

If No, please specify _____

b) Is this question is in a wrong or inappropriate category? (Operational) Yes No

If Yes, please recommend a category _____

c) Please rate the relevance of this question to your company's operation:

Least 1 2 3 4 5 most relevant

Please state why:

d) Will data be hard to obtain in order to answer this question? Yes No

If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Q18) What is your forecast accuracy of customer demand?

_____ %

a) Do you understand the key terms of this question? Yes No

If No, please specify _____

b) Is this question is in a wrong or inappropriate category? (Operational) Yes No

If Yes, please recommend a category _____

c) Please rate the relevance of this question to your company's operation:

Least 1 2 3 4 5 most relevant

Please state why:

d) Will data be hard to obtain in order to answer this question? Yes No

If Yes, please indicate why?

(A) Data is too confidential	(B) Data is not collected by my company
(C) Data is not directly available to me. (someone else has the data, who? _____)	(D) Data is available but will take significant resources or time to obtain

Other, please specify:

Appendix D: Feedbacks from Survey Evaluation

The following is the collected feedbacks from three transportation companies.

Q1) What trailer size is commonly used in your company (Give at most three different sizes)?

Do you want length only or also width and height? Inside or outside?

Must be more specific than size. Each mode – dry van, temp control, flatbed, bulk, tanker, etc., has its own equipment type, size is a minor factor. Question most relevant to company's operation because equipment size impacts shipper's cost and ship quantity.

Key factor

Q2) On average, how much time is needed to load goods into the trailer (that is commonly used)?

_____ hour → Trailer size _____
_____ hour → Trailer size _____
_____ hour → Trailer size _____

So much variations (e.g. between loose and palletized) that validity of question is suspected.

I believe there is no significant relationship between load/unload time and trailer size. I would give a 4 –5 for "Dock dwell time" information. Same comment on Q3

Q3) On average, how much time is needed to unload goods from the trailer (that is commonly used)?

_____ hour → Trailer size _____
_____ hour → Trailer size _____
_____ hour → Trailer size _____

Floor vs. pallet has an impact on Q2 and Q3

See Q2. These are more relevant to TL carriers.

Q4) How many trucks (available within trailer operation) does your company have?
_____ trucks

Line haul power? Include city strangest trucks. "Truck" is too imprecise.

(available within trailer operation = does not make sense to the reviewer)

(Are you asking how many tractors the operation has. If simply asking for a truck count, it is easy to answer)

Q5) Among the trucks, how many of them are actively in operation? (i.e. trucks that are driven every day) (# of trucks active in operation)

See Q4 comments on "trucks".

(driven = How do you define "Driven". Perhaps, ask "how many units are out of service, wrecked, repair)

(Utilization is a key performance measure)

(Most maintenance functions provide daily "in shop" reports, therefore, data is not hard to get)

Q6) What is the average load size for the trailer that is commonly used in your company? (Load capacity)

Data hard to get (Must rely on data input from outside sources leaving the integrity less than desirable

For all lanes. Including empty movements? Miles weight, shipment weight.

Q7) On average, how many stops do your trucks usually make in a route?

(A "Stop" is a stopping point in a truck route for loading and unloading only)

_____ Stops

For city operations? No stops in line haul operations.

(Is the minimum # of stops =2 ? This should be clarified so consistent answer are given)

Q8) How much time does a truck typically spend during a stop?

_____ hours (Stop Time)

(How is this different from Q3?)

(We speak in terms of initial, immediate, and final stops)

Q9) On average, what is the amount of time driven between two stops?

_____ hours

Data hard to get. Easier to provide miles between stops. We collect "arrival" times and could calculate the time between stops)

Q10) What is the average speed of the truck during operation?

_____ mph

Road operations? Some difficulty. City operation? Different if not impossible.

(Are you wanting avg transit MPH? Average driving speed? Should I include stop times? More definition around the question will make it easier to answer)

Q11) What is the average operating hours per truck in a week? (operating hour/truck)

_____ hours/truck

(Equipment utilization is key factor)
(Not a measure we keep. Miles/truck is how we track "up time" we could calculate this measure [miles/(truck/week) * (average hrs/mile)])

Q12) On average, how many hours does a driver work in a week?

_____ hours/week

(City or road?)

(How do you define work? Are you using dot definitions?)
(Random sample of driver logs would be required. Some drivers are paid hourly. This would be easy to collect)

Q13) What percent of the time is a truck is driven empty?

_____ percent

Clock time? Miles moved be much more relevant? City or road?

(Better state as "what percent of your total miles run are empty?" Another key metric)

Q14) On average, what is the average length of a route?

_____ miles (Average distance traveled)

(Do you want the loaded length of haul for the average shipment?)

Q15) How many times does a driver repeat a route in a week?

_____ times

What if another driver requests the route? What if stops vary slightly?

(data not collected = we are an irregular route carrier. Where we do have regular routes, we do not capture who runs what route how often. A key obstacle is we do not have routes with unique identities in our mis)

Q16) What is your truck tracking accuracy (Tracking accuracy = the # of trucks with a known location / Total # of trucks)?

_____ %

(All of our trucks have a known location whether it is accurate is another question)

(data is hard to get, would require a random sample to verify and calculate our location data accuracy)

Q17) What is your inventory record accuracy? (Inventory Record Accuracy = # of correct records / Total # of Records)

_____ %

(we maintain no inventory records, outside of maintenance and repair areas)

Q18) What is your forecast accuracy of customer demand?

_____ %

(At what level of detail: company, mode, region, lane, customer?)

(relevant rating =4, we plan our volumes and track our progress against this goal. It is more of a sales forecast)

(Question needs more definition to answer accurately)

Customer Satisfaction

Q19) How many customer orders does your company typically receive in one week?

_____ orders

Shipments? Pickup requests? Marketing?

Q20) Among the orders received, what percent of them receive complaints from customers?

_____ % complaints

We collect payment and exceptions and frequent loss or damage.

(Hard to answer= no track on time pickup, ontime delivery, not customer complaints)

Q21) Among the orders received, what percent of them were immediately processed within 24 hours? (on time order entry)

_____ % orders

(data not collected = the lag between the receipt of the information, and the actual entry of the information is not captured or we have many ways to receive info (EDI, FAX, internet, phone))

Q22) Among the orders received, what percent of them were delivered without delay?

_____ % Orders delivered (on time delivery)

However, N carriers have N ways of measuring.

Q23) Among the orders received, what percent of them were delivered to the destination correctly? (Correct destination rate)

_____ % Order delivered to correct destination

(Over, shout and damaged claim frequency would be a better question)
(rephrase the question will help)

Q24) Among the orders received, what percent of them were returned?

_____ % Orders (order returned)

(not important = very few deliveries are refused. Virtually none are due to JBHT actions)

Q25) Among the orders received, what percent of them were received from customers who have a business history with your company?

_____ orders (re-purchase rate)

(Any shipment were out?)

(we have over 6000 customer; nearly every truckload shipper. How do we define "business history"? Perhaps saying "have shipped with your company on the past years" would help qualify the answer)

Q26) Among the orders received, what percent of them were loaded into trucks on time?

_____ orders (On time loading)

(N/A)

Q27) How many shipments does your company deliver in one week? (A shipment is defined as a loaded trailer)

_____ Shipments / week

(Our average loaded trailer has 40 shipments to 40 different consigners.)

Q28) Among the shipments delivered, what percentage of them were on time?

_____ % delivery (Delivery date compliance)

(How different from Q23)

(How is this different from Q22?)

(Do you mean delivered on the first requested date? We measures ours to the minutes in some cases. The question should be phrased to ensure consistent responses)

Q29) What percentage of damage free shipments do you deliver in one week?

% _____/week

(How is week relevant? This is a ratio? Do you mean "last week" (or month, year), of the shipments you delivered, what percentage were damage free?)

Q30) What percentage of shipments did you deliver to a correct destination in one week?

% _____/week

(How different from Q23?)

(how is this different from Q23?)

Q31) Among the shipments delivered, how many customers returned the product and requested a claim?

_____/week (claims rate)

Many claims don't involve a return. What about lost product?

(This reads like "how many loads were refused due to product damage")

(Important to ship freight in a safe, damage free manner)

Q32) What is your order entry data accuracy?

_____ %

Transaction bill entered correctly? Include rate application? Before internal audit & correction?

(Poor info quality = errors = extra cost and poor service)

(can be a operational question)

(data hard to obtain. No automated identification)

Warehouse Effectiveness

Q33) Do you have at least one warehouse (private/public) in your network?

Yes _____ No _____

If Yes, proceed to question 41

If No, Skip this section

(N/A)

Q34) What is the warehouse's pick rate? (Pick rate = # of lines picked per person per hour / lines for all orders)

_____ lines/ person/ hour

(N/A)

Q35) What is your warehouse's fill rate? (Fill rate = # of filled orders / Total # of orders)

_____ lines/ person/ hour

(N/A)

Q36) What is your average annual expense on material handling?

\$ _____/year (material handling rate)

(N/A)

Q37) What is your material handling asset value?

\$ _____

(N/A)

Q38) What is the annual usage of your inventory (at cost)?

\$ _____/year

(N/A)

Q39) What is the average asset value of inventory in your warehouse?

\$ _____

(N/A)

Q40) What is your warehouse maintenance efficiency?

\$ _____/maintenance activity

(N/A)

Financial Measures

Q41) What is your driver's wage rate?

\$ _____/hour

City or road with or w/o OT? W/o fr...? Road paid per miles

(more generic question would be better. Drivers are paid many ways other than by an hourly rate. Ask “ what is your driver wage expense as a % of revenue” or “ what is your drivers’ average annual gross pay)

(It is important because driver wage is most/all trucking co’s largest single cost)

Q42) What is your monthly truck maintenance cost?

\$ _____/month

(Repairs? Routine? Collision? Fuel? Depreciations?)

(Also a large and significant operating expense)

Q43) What is the average direct cost (truck depreciation, insurance, leasing) per truck of your company ?

\$ _____/truck

(Insurance= often not on a “per truck” basis. Other costs/truck would include licenses and permits)

Q44) What is the average variable cost (fuel, tire, maintenance, etc) per truck for your company?

\$ _____/truck

(Also, average age of equipment is directly correlated with maintenance exp especially)

Q45) On average, how much revenue can be generated by one truck?

\$ _____/truck

(City or road? One dispatch? A shipment may be in 3 different trailers across the system.)

(truck: per time unit, per week, or workday is most common)

Q46) On average, how much revenue can be generated in one trip?

\$ _____/trip

Not really relevant from LTL

(Not sure it is meaningful, one company’s trip could be quite different from another’s)

Q47) What is the average number of transactions (transactions associated with taking customer orders) you make per week?

_____/week

(Customer contacts? Internal?)

(Transaction needs more definition, not clear what we are after)

Q48) What is the average cost per transaction per week?

\$ ____/week

(Same problem only worse)

(Transaction is much too generic)

Q49) What is your average total logistics operating expense per month? (Fuel, truck maintenance, support personnel, etc)?

_____/month

(Needs further definition, by ICC numbers?)

(Not sure it is relevant or comparable from one company to another)

Q50) What is your company average shipment cost per month? (Shipment cost)

\$ ____/month

(Ratio: Time period is not relevant)

(Total cost/Total shipments? Last month? Last year?)

(Same reason as above)

Q51) How many orders do you complete in one week?

_____/week (Complete order)

(What is an order? Complete=delivered? Pick up deliver in same week? Operational or marketing?)

(For truckload carriers, 1 shipment = 1 orders, making this a redundant question (#27 is similar)

Q52) What is your percentage return on asset?

_____%

(Pretax? Include intangibles?)

(Key financial performance measure, can be obtained from public documentation)

Q53) What is your percentage return on investment?

_____ %

(Investment: Stockholder's equity?)

Q54) What is your annual revenue growth rate?

_____ %

(Over what time period?)

(Growth is an objective. Also, good to compare against competitors)

Employee Performance

Q55) What is the average number of workdays your company schedules in a month?

_____ days

(Road operations? Excludes Thanksgiving & Christmas Eve and Christmas)

(workdays: for whom?)

(Helps normalize performance measures to a per weekday common denominator)

Q56) How many employees does your company currently have?

_____ employees

(Full time equivalent or bodies? That work anytime during last month)

Q57) Among your employees, how many of them are truck operators?

_____ drivers

(City or road, what about combo dock and city?)

(Need to know driver counts for comparison purposes. Also, good to see driver to other employee ratios)

Q58) What is your truck driver absentee rate? (Absentee rate)

_____ %/month

(Road vs. city. More definitions? Road driver run refusals may be hard to capture)

(Not a measure we employ. We track # of drivers working. There is no work schedule to be absent from)

Q59) Do you provide training for your truck drivers?

Yes _____ No _____

If yes, how many training hours are provided to the drivers?

_____ hours/person/year

(Drivers are key factor)

(Accident: Standardize. DOT reportable is a good standard)

Q60) On average, how many traffic accident(s) are reported every month?

_____ accident/month

(Both city and road?)

Q61) What is the average education level of your drivers?

Primary school graduate _____

High School graduate _____

College graduate _____

University _____

(Years of driving experience is what matters)

Q62) What is your employee turnover rate?

_____ %/year

Include terminal...? Retirements?

(Driver retention is the # 1 operating challenge in the business)

Q63) Do you offer any recognition to your outstanding employees?

Yes _____ No _____

If Yes, what recognition do you offer?

(N/A)

Q64) On average, how many promotions are given in one year?

_____ Promotions/year

(Need to define "promotion" and what type of employee you are referring)

Q65) On average, how many employment opportunities does your company offer in a month?

_____ Offers/month

(Need to segregate by type of employee)

(Not sure how knowing this and benchmarking it will help me improve operations)

Q66) What percentage of offers are accepted?

_____ % Offers

(same as above)

Q67) How many complaints, disputes about company practices are received per month?

_____ Grievances / month

(Not a major issue)

Company 1:

Do you recommend adding any more categories? Yes _____ No _____

If Yes, what categories do you recommend? safety, risk management, collisions, cost/ collisions, worker compensations

Do you recommend adding any more performance metrics? Yes _____ No _____

If Yes, what performance metrics do you recommend? Please indicate the metric's category.

(You may have most of these, but here goes:

miles/truck/week

empty miles as % of total

DOT report tables per million miles driven

Loads/trailer/time period

Driver turnover%

Average loaded length of haul

Average # of dispatches/load

Average MPG

MTNC cost /mile

Trailer, tractor ratio

Average nights a driver is home per week

Average rate per loaded mile

of customer (active)

Company 2:

Do you recommend adding any more categories? Yes _____ No _____

If Yes, what categories do you recommend? _____

Do you recommend adding any more performance metrics? Yes _____ No _____

If Yes, what performance metrics do you recommend? Please indicate the metric's category.

Company 3:

Do you recommend adding any more categories? Yes _____ No _____

If Yes, what categories do you recommend? _____

Do you recommend adding any more performance metrics? Yes _____ No _____

If Yes, what performance metrics do you recommend? Please indicate the metric's category.

Comments on survey:

This survey is very directed to TL carriers. Will take substantial work to make it relevant to other sectors, eg. TL.

Appendix E: Use Case List

Use case group: (i) User/System Interaction

Use Case: Browse Online Benchmarking System

Definition: A user may browse the system on the Internet so that he/she can determine if the website is of any interest to them. The user can check out the Frequently Ask Question page, contact us for any question, visits the “link” page or check out what we have to offer.

Actor: All possible web surfers.

Use Case: Take Survey

Definition: Surveys are available online so that users who are interested in participating in taking a survey can fill out an electronic survey form easily. The survey respondent has to go to a designated web page that contains the survey.

Actor: Transportation service provider (TSP) - Transportation service provider is the company that provides transportation services.

Scenarios:

Actor (TSP)	System
Click “Survey” link	
	Display all surveys that are available in the system
Select a survey by clicking on it	
	Display the survey questions
Fill out the questionnaire Click “Submit” button after the user completed the questionnaire	
	Perform error checking - If error is detected, display error message and ask user to correct the error - Else, display message to thank the survey taker.

Use Case: View Performance Metrics List

Definition: Users view or perform searches on the performance metrics online.

Actor: TSP

Use Case: User Login

Definition: The system requires the user to set up an account in order to keep track of the user’s activity. The user needs to enter a login name and password to gain access to the system resources.

Actor: TSP

Scenarios:

Actor	System
Click on the "Login" link in the homepage	
	Show the login page
Enter user name and password	
	If login successful, then show the home page. Else, show the error message

Use Case: User Registration

Definition: A user registers so that he/she can use the SMART online application.

Actor: TSP

Scenarios:

Actor	System
Click on the "registration" link on the homepage	
	Show the registration page
Fill in the user information in the registration page. Click "Submit" button after information has been entered successfully	
	Perform form validation in the background If no error found, then show the homepage If error exist, then show the error message

Use Case: Using SMART online application

Definition: A user use SMART decision tools online so that he/she can compare his/her aggregate performance with other participants.

Actor: TSP

Scenarios:

User	System
User click on the "SMART" link to start using the application on the homepage	
	Check if user has logged in already. If not, then display error message. Else show the scorecard selection page
Case 1: User clicks on the "create a new scorecard" checkbox and then click on the "submit" button. Case 2: User clicks on the name of an existed scorecard so that update can be	

made to the scorecard Case 3: User clicks on the name of an existed scorecard so that delete action can be made to the scorecard.	
If “case 1” is selected.	
	Display the scorecard naming page
User enters a name for the scorecard. Then, click on the “submit” button	
	Check if name is entered, if not, then display error message Else, show the metric selection page
User selects metrics. Then, click on the “submit” button	
	System validates the value entered. If no error found, then show the metrics weight and value page. Else, display error message.
User enters the value of metrics and weights. Then, click on the “submit” button	
	System validates the value entered. If no error found, then display the “category weight assignment” page. Else, display error message.
User enters the category weight values. Then, click on the “submit” button	
	System validates the value entered. If no error found, then display the calculated result of aggregate performance for the current user as well as other users, who have the same selected metrics as the current user.
If “case 2” is selected.	
	System shows all the selected metrics. Then, the user can add, delete metrics, or proceed to the next step.
If user selects at least one metric and clicks the “delete” button.	
	The system deletes the selected metric.
If user clicks the “Add” button	
	The system shows the metric adding page. The user can add more metric here. Then, the user can either continue to edit the metrics or proceed to the next step.
If user clicks the “continue” button.	

	System shows the metrics weight and value page. All the values and weights are automatically fill in as the user has entered them in the previous attempt
User updates the metrics values and weight as needed. Then, click on the “submit” button.	
	System validates the value entered. If no error found, then display the “category weight assignment” page. Else, display error message.
User updates the “category weight” as needed. Then, clicks on the “submit” button	
	System validates the value entered. If no error found, then display the calculated result of aggregate performance for the current user as well as other users, who have the same selected metrics as the current user.
If “case 3” is selected	
	System confirms the user concerning the “delete action”.
User click on the radio button (that provide authority to either delete or not to delete) to indicate appropriate action that should be taken.	
	If “Yes” is selected, then, scorecard is deleted and use is redirected to the SMART homepage If “No” is selected, then nothing is deleted. User is redirected to the SMART homepage.

Use case group: (ii) System Administration

Use Case: Update benchmarking website

Definition: Feedback, recommendation and request collected will be evaluated and appropriate changes will be made to update the website.

Actor: System admin

Use Case: Update website database

Definition: Feedback, recommendation and request collected will be evaluated and appropriate changes will be made to update the database.

Actor: System admin

Appendix F: Classes and Attributes

Class: Survey

Description: A survey is a useful way to collect general information. In addition, a benchmarking team can develop a baseline for performance comparison and measurement as well. Specifically, a survey consists a set of questions that may consist of multiple-choice, open-ended question and fill in the blank question.

Attribute: Title

Description: A string of text that describes the title of a survey.

Domain: Text string

Attribute: Instruction

Description: A brief instruction directed to the survey participant so that the respondent can better understand a survey.

Domain: Text string

Class: Questions

Description: Question is a request for information or for a reply, which usually ends with a question mark if written or on a rising intonation if spoken.

Subclass: Multiple choice

Description: Multiple choices is a request for a reply or information by providing several predetermined answers, in which a person may choose more than one, depending on the situation. Note that both scale question and forced choice question are sub-type of multiple choice.

Attribute: Choice

Description: A choice is a string of text or numbers that act as a response or answer to a question. More than one choice can be selected as the answer for multiple-choice question.

Domain: Text string and number

Subclass: Single choice

Description: Single choice is a request for a reply or information by providing several predetermined answers, in which a person may choose only one, depending on the situation.

Attribute: Choice

Description: A choice is a string of text or numbers that act as a response or answer to a question. Only one choice can be selected as the answer for a single choice question.

Domain: Text string and number

Subclass: Open ended

Description: It is a request for a reply by providing a blank space to a question into which a respondent may fill in an appropriate reply.

Attribute: Blank

Description: It is a short blank space (usually does not exceed the length of one screen row) provided to respondent to fill in answer(s).

Domain: Text string, number

Class: Registered User

Description: A registered user is a person who registered online in the benchmarking website so that he/she can use some features in the website.

Attribute: First Name

Description: A name that describes the first name of the registered user.

Domain: A text string

Attribute: Last Name

Description: A name that describes the last name of the registered user.

Domain: A text string

Attribute: Company Name

Description: A name that describes the name of the company that the registered user currently works.

Domain: A text string

Attribute: Phone number

Description: A phone number is a text string of number that can be used to make a phone call. This is the phone number of the company that a registered user currently works.

Domain: An text string in the form ###-###-####

Attribute: Email address

Description: A user name and domain name that can be used to send or receive email.

Domain: A text string in the form UserName@DomainName

Attribute: User name

Description: A user name that is selected by the registered user as the login information and validation.

Domain: A text string or number or combination of both.

Attribute: password

Description: A string or number or combination of both that is selected by the registered user as the login validation and information.

Domain: A text string or number or combination of both

Class: Mailing Address

Description: A mailing address is a mail location specified by the registered user. The address describes the street name, lot number, name of city, zip code and state of a company or workplace.

Attribute: address

Description: An address describes the house number and street name where a specific subject receives mail. The subject can be a workplace, house, or any place mail is received.

Domain: A text string consisting of a number and a street name.

Attribute: city

Description: A city refers to the city portion of a mailing address.

Domain: A text string

Attribute: state

Description: A state describes the U.S. state of where a specific subject receives mail. Mailing code abbreviations will be used.

Domain: A two-character text string.

Attribute: Zip code

Description: A zip code describes the postal code of a subject's address

Domain: An text string in the form #####, or #####, or #####-####, where # represent a number

Attribute: country

Description: The name of a country

Domain: A text string

Class: Performance Metric

Description: Performance metric is a set of parameters that one uses to measure the performance of a process.

Attribute: Name

Description: A name that describes the name of the metric

Domain: A text string

Attribute: Definition

Description: A concise explanation of the meaning of a metric.

Domain: A text string

Attribute: Unit

Description: A standard of measurement for a particular metric.

Domain: A text string

Attribute: Formula

Description: Formula can be defined as a conventionalized statement expressing some fundamental principle. A metric may associate itself with a formula so that the value of the metric can be calculated.

Domain: A text string or scientific symbol

Attribute: Purpose

Description: Describes why the metrics is needed or important

Domain: Text string

Attribute: Discussion

Description: Discussion of the metric will include the origin of the metric and its properties

Domain: Text string

Attribute: Collection Frequency

Description: Collection frequency describes how often one collects the metric

Domain: Number

Attribute: Collection Method

Description: A description of the method that is used to collect the metric.

Domain: Text string

Class: Category

Description: Category is the groupings that are suggested in the balance scorecard.

Attribute: Name

Description: A description of the name of the category

Domain: Text string

Class: Weight

Description: Weight is associated with both performance metrics and category. This is the weight that is assigned by a registered user when the user tries to use the "SMART" application in the website.

Attribute: Value

Description: A number that describes the weight of a metric or a category

Domain: Number

Class: Answer

Description: This is the answer that is supplied by a registered user by responding to the online survey.

Attribute: Value

Description: The value of an answer to a particular question.

Domain: Number or string or both

Class: Scorecard

Description: Scorecard is actually a collection of performance metrics, metrics weight, and category weight that is selected and assigned by a registered user. The data recorded in the scorecard is used to calculate the aggregate performance for the user.

Attribute: Name

Description: A name that describes the scorecard

Domain: Number or text or combination of both

Attribute: Creation Date

Description: A date that records the creation of a scorecard

Domain: A number in the following format: day/month/year or ##/##/##

Appendix G: Snap Shots of Online Benchmarking System

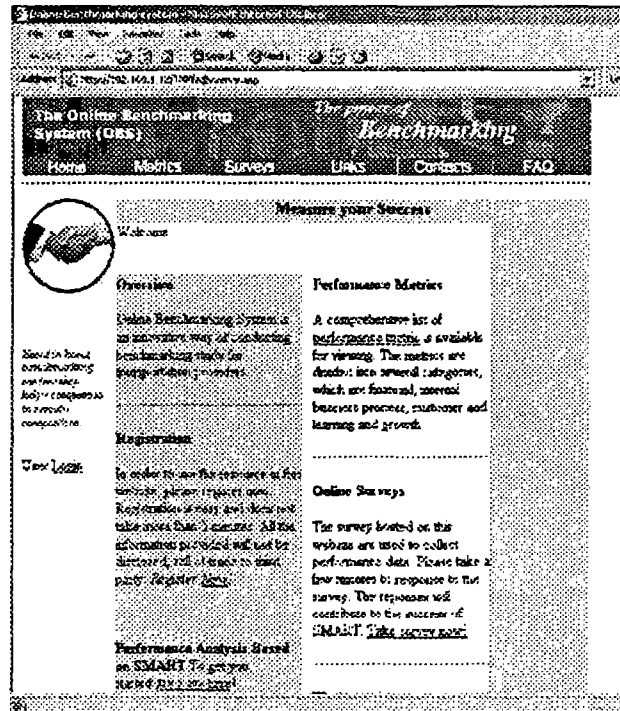


Figure G1. Homepage of website

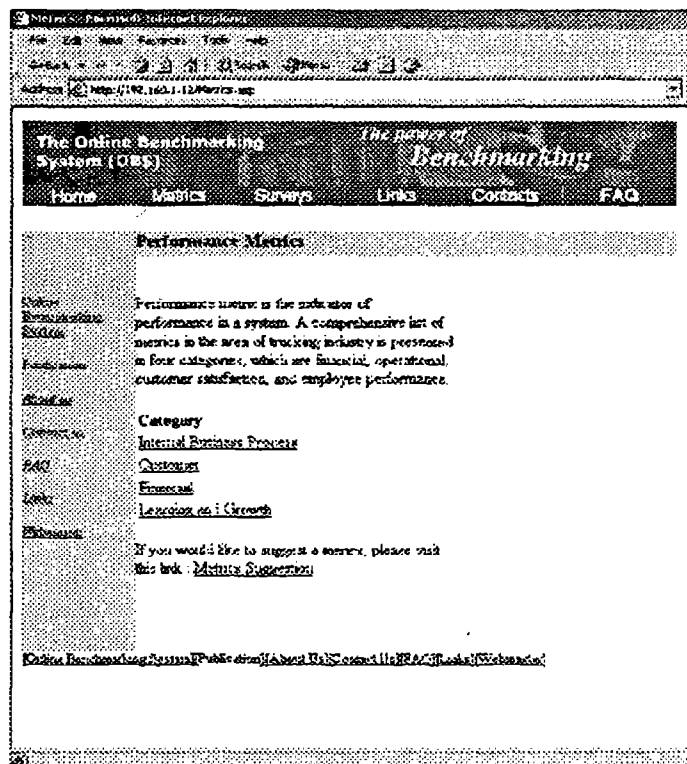


Figure G2. Performance metric selection page

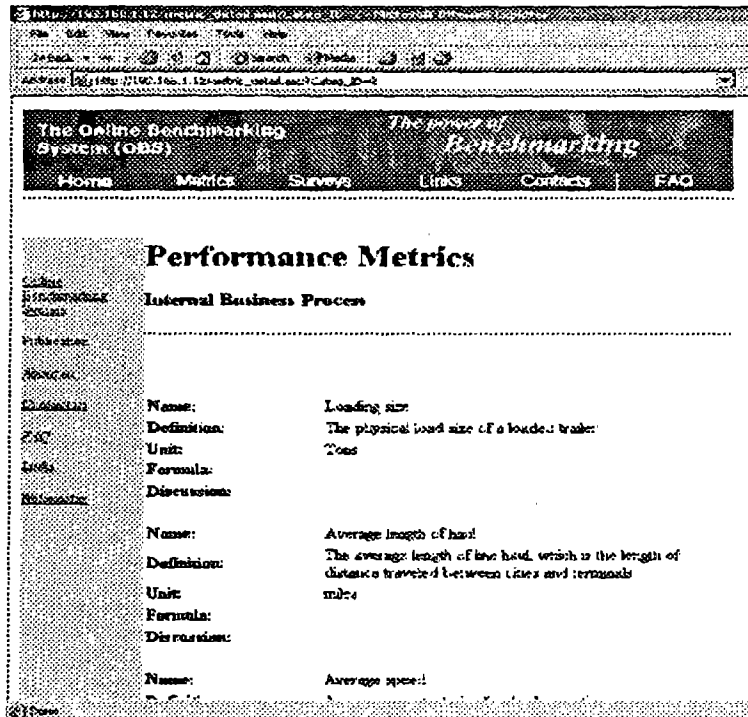


Figure G3. Performance metric detail page

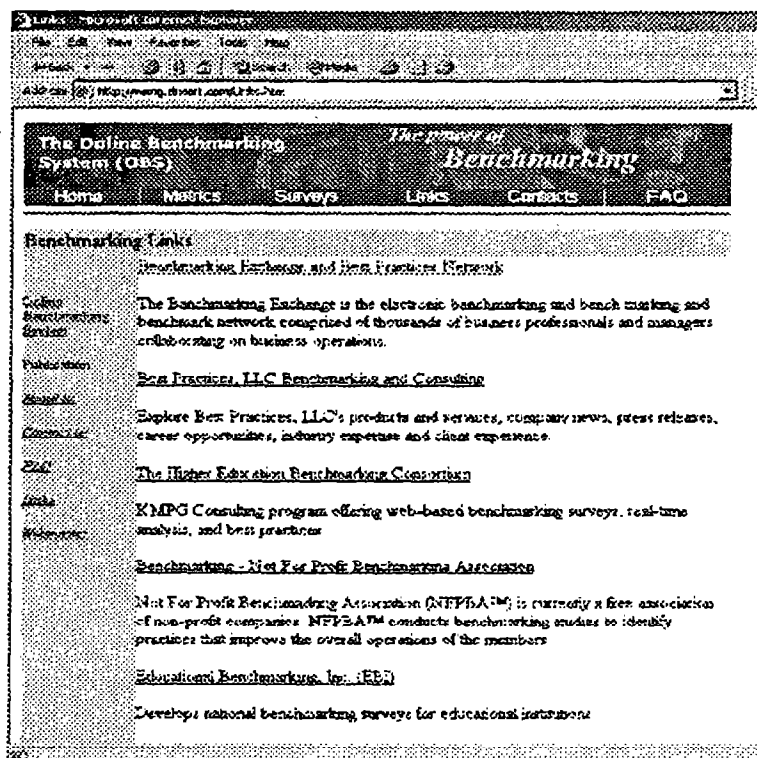


Figure G4. Benchmarking links page

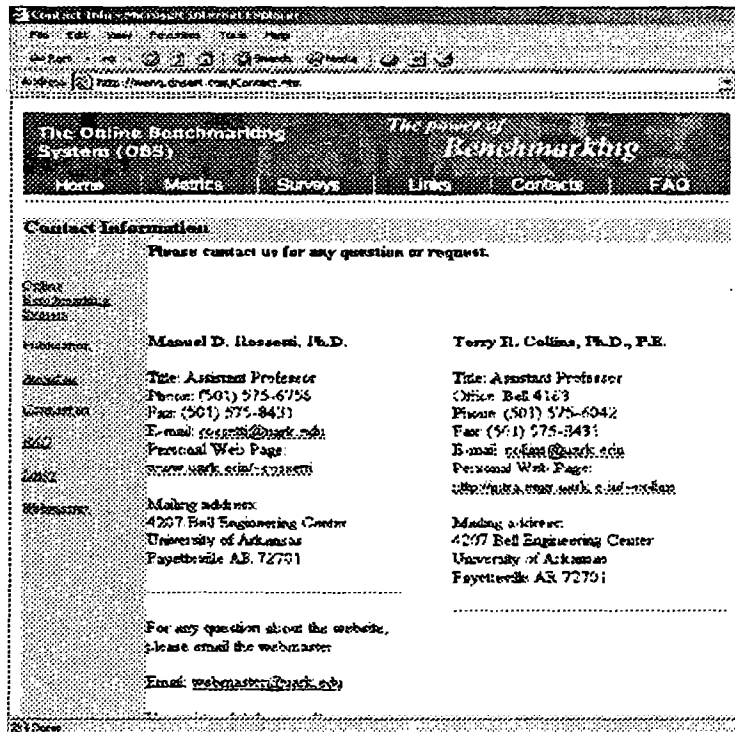


Figure G5. Contact page

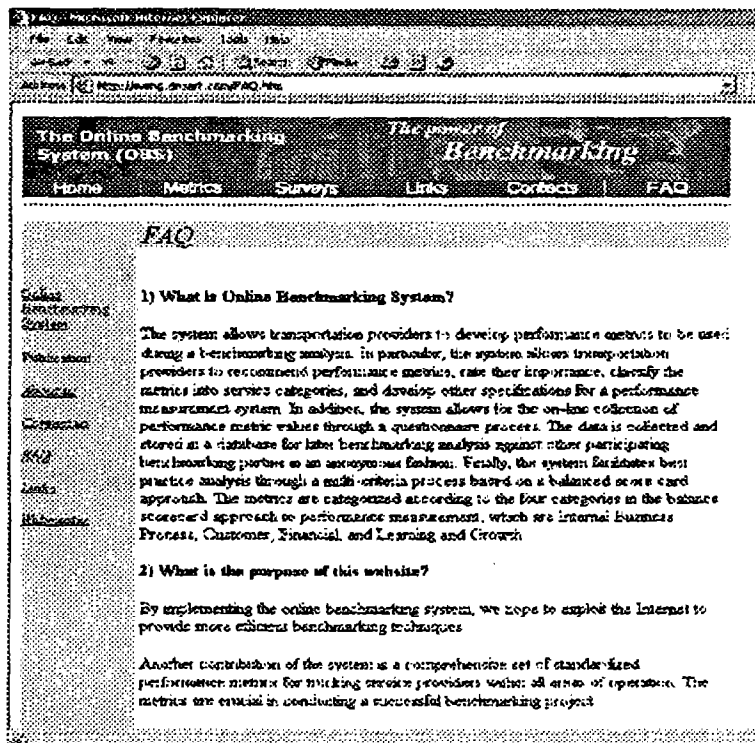


Figure G6. FAQ page

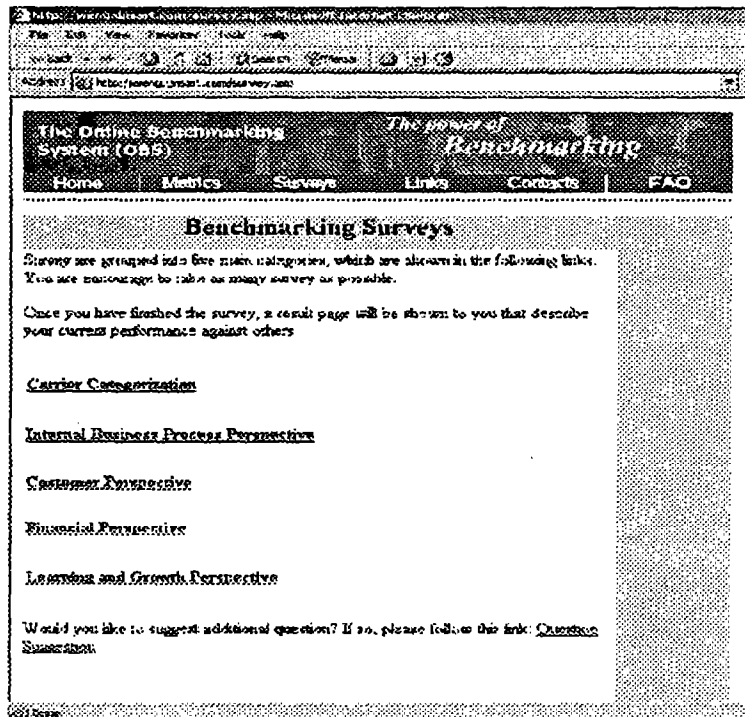


Figure G7. Survey Selection page

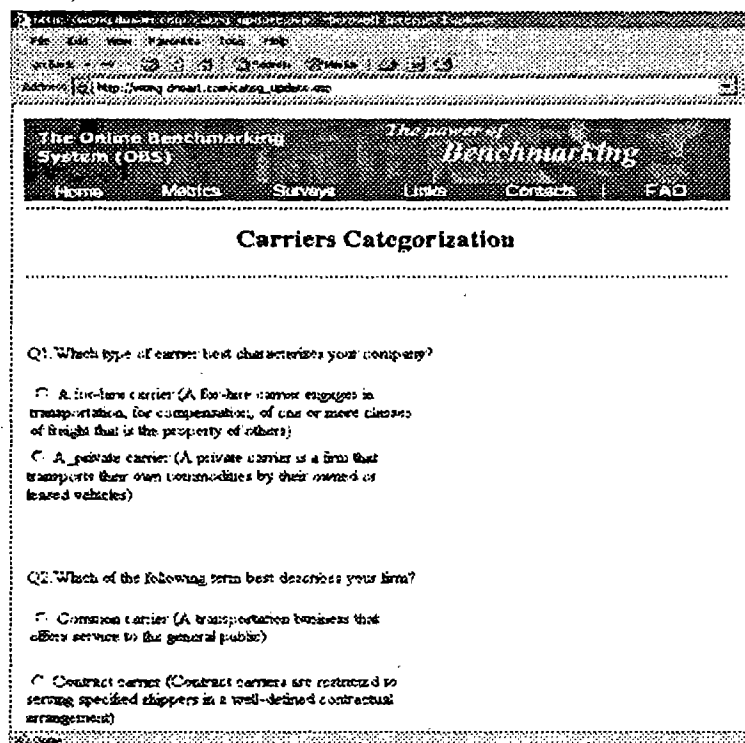


Figure G8. Survey Question page

The Online Benchmarking System (OBS) *The power of Benchmarking*

Home Metrics Surveys Links Contacts FAQ

Registration

About you

Last Name*

First Name*

Email*

About your company

Company Name

Address line 1

Address line 2

City

Links: Home, Metrics, Surveys, Links, Contacts, FAQ

Figure G9. User registration page

The Online Benchmarking System (OBS) *The power of Benchmarking*

Home Metrics Surveys Surveys Contacts FAQ

Members Login

Please enter your user name and password

User Name

Password

☐ Remember me

If you have never registered before, click [here](#)

Figure G10. User Login page

http://www.benchmarking.com/submit_question.asp

File Edit View Favorites Tools Help

Back Forward Stop Reload Home

Address http://www.benchmarking.com/submit_question.asp

The Online Benchmarking System (OBS) *The power of Benchmarking*

Home Metrics Surveys Links Contacts FAQ

Would you like to suggest question(s) for us?

Use the following form to send us the suggestion

Your Email:

Enter question information here:

Question type:

Body of question:

Submit

Figure G11. Question suggestion page

http://www.benchmarking.com/submit_metric.asp

File Edit View Favorites Tools Help

Back Forward Stop Reload Home

Address http://www.benchmarking.com/submit_metric.asp

The Online Benchmarking System (OBS) *The power of Benchmarking*

Home Metrics Surveys Links Contacts FAQ

Would you like to suggest a performance metric for us?

Use the following form to send us the suggestion

Your Email:

Enter Metrics information here:

Metric Name:

Metric Definition:

Submit

Figure G12. Performance metric suggestion page

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